APX™ P25 Mobile
TWO-WAY RADIO

APX Mobile Radios Control Head Basic Service Manual

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Contents

List of Figures **10**
List of Tables **19**
Foreword **22**
Product Safety and RF Exposure Compliance 22
Intellectual Property and Regulatory Notices 22
Document History **24**
Notations Used in This Manual **26**
Related Publications **27**
Commercial Warranty **28**
I. What This Warranty Covers And For How Long 28
II. General Provisions 28
III. State Law Rights (Applicable Only in U.S.A.) 29
IV. How To Get Warranty Service 29
V. What This Warranty Does Not Cover 29
VI. Patent And Software Provisions 30
VII. Governing Law 30
Chapter 1: Introduction **31**
1.1 Radio Description 31
1.2 FLASHport® 34
1.3 Control Head Descriptions 34
1.3.1 O2 Control Head 35
1.3.2 O3 Control Head 36
1.3.3 O5 Control Head 37
1.3.4 E5 Control Head 38
1.3.5 O7 Control Head 39
1.3.6 O9 Control Head 40
1.4 P25 Digital Vehicular Repeater System 41
1.5 APX Mobile Radios Model Numbering, Charts, and Specifications 41
1.5.1 VHF Radio Specifications 42
1.5.2 UHF R1 Radio Specifications 46
1.5.3 UHF R2 Radio Specifications 50
1.5.4 700–800 MHz Radio Specifications 54
1.5.5 900 MHz Radio Specifications 58
Chapter 2: Basic Maintenance **61**
2.1 Preventive Maintenance 61

2.1.1 Inspection....61
2.1.2 Cleaning Procedures....62
2.1.3 General Radio Care and Handling Precautions....62
2.1.4 RF Power Amplifier (RF PA) Heatsinking....63
2.2 Safe Handling of CMOS and LDMOS Devices....63
Chapter 3: Basic Theory of Operation....64
3.1 General Overview....64
3.2 Controller Board....67
3.2.1 Location....69
3.2.2 Microprocessor/Memory....72
3.2.2.1 Microprocessor....72
3.2.2.2 FLASH IC....73
3.2.2.3 SDRAM IC....73
3.2.3 Voltage Distribution/Power On/Off....74
3.2.3.1 Voltage Distribution for Controller and RF Board....75
3.2.3.2 Power On/Off....75
3.2.3.3 Emergency....76
3.2.4 Audio Circuitry....76
3.2.4.1 RX Audio Path....76
3.2.4.2 TX Audio Path....77
3.2.5 Secure....77
3.2.6 GPS Overview....78
3.2.7 Serial Interfaces....79
3.2.8 Accessory Power....82
3.3 Option Board Assembly....83
3.3.1 Managed NAND....83
3.3.2 Forced Fail Functionality....83
3.3.3 3-Day Secure Key Retention....83
3.4 Control Heads Assembly....84
3.4.1 OMAP Microcontroller....84
3.4.2 Kinetis K32H Microcontroller....85
3.4.3 Field-Programmable Gate Array (FPGA)....85
3.4.4 Controller Area Network (CAN) Transceivers....85
3.4.5 Power Management....86
3.4.6 SPI Controller....87
3.4.7 Flash IC....87
3.4.8 SDRAM IC....87
3.4.9 Color Liquid Crystal Display (LCD) module for O3....87
3.4.10 Bi-Color Backlit BW Liquid Crystal Display (LCD) module for O5....88

3.4.11 TFT Liquid Crystal Display (LCD) module for O9..... 88
3.4.12 TFT Liquid Crystal Display (LCD) module for O2 and O7.....88
3.4.13 TFT Liquid Crystal Display (LCD) module for E5.....88
3.4.14 O3 Remote Mount.....88
3.4.15 O2 and O7 Remote Mount.....89
3.4.16 O9 and Transceiver Interface..... 91
3.4.17 E5 and Transceiver Interface.....92
3.4.18 Vehicle Interface Port (VIP)..... 92
3.4.18.1 O2/O3/O5/E5/O7/O9 Remote-Mount.....92
3.4.18.2 O5 Dash-Mount (Mid Power Only).....95
3.4.18.3 E5 Dash-Mount (Mid Power Only)..... 96
3.4.19 Data Entry Keyboard (DEK).....97
3.4.20 CAN Termination Section..... 99
3.5 Control Head Interface Board (CHIB).....100
3.5.1 FPGA Section..... 103
3.5.2 Audio Section.....103
3.5.3 Power Section.....103
3.5.4 Connectivity Section..... 103
3.6 O2/O5/E5/O7/O9 Control Head Universal Connector (CHUC).....104
3.7 O9 Universal Relay Controller Operation..... 104
3.7.1 Universal Relay Controller Architecture.....104
3.7.2 Controller Section..... 105
3.7.3 Power Management Section.....105
3.7.4 Power Relays Section.....105
3.8 Transceiver Interface Board (TIB)..... 106
3.8.1 Quick Disconnect Circuit.....106
3.9 Analog Mode of Operation.....107
3.9.1 Receive Operation..... 107
3.9.2 Transmit Operation..... 107
3.10 ASTRO Mode of Operation.....108
3.11 Radio Frequency Transceiver Board (RF Board)..... 108
3.11.1 Radio-Frequency Power Amplifier (RF PA) and Output Network (ON)..... 108
3.11.2 Gain Stages..... 108
3.11.3 Power Control..... 108
3.11.4 Circuit Protection.....109
3.11.5 DC Interconnect.....109
3.12 VHF Receiver Overview..... 109
3.12.1 Receiver Front-End.....109
3.12.2 Mixer..... 110

3.12.3 IF Circuitry....110
3.12.4 Receiver Back-End....110
3.13 UHF R1 & R2 Receiver Overview....111
3.13.1 Receiver Front-End....111
3.13.2 Mixer....111
3.13.3 IF Circuitry....111
3.13.4 Receiver Back-End....112
3.14 700–800 MHz Receiver Overview....112
3.14.1 Receiver Front-End....112
3.14.2 Mixer....112
3.14.3 IF Circuitry....113
3.14.4 Receiver Back-End....113
3.15 900 MHz Receiver Overview....113
3.15.1 Receiver Front-End....113
3.15.2 Mixer....113
3.15.3 IF Circuitry....114
3.15.4 Receiver Back-End....114
3.16 Frequency Generation Unit....114
Chapter 4: Test Equipment, Service Aids, and Tools....117
4.1 Recommended Test Equipment....117
4.2 Service Aids and Recommended Tools....118
4.3 Mobile Radios Field Programming and Equipment....122
Chapter 5: Performance Checks....124
5.1 Test Setup....124
5.2 Test Mode....124
5.2.1 Entering Test Mode....124
5.2.2 RF Test Mode....126
5.2.3 O2 Control Head Test Mode....128
5.2.4 O3 Control Head Test Mode....129
5.2.5 O5 Control Head Test Mode....131
5.2.6 E5 Control Head Test Mode....132
5.2.7 O7 Control Head Test Mode....133
5.2.8 O9 Control Head Test Mode....135
5.3 Receiver Performance Checks....137
5.4 Transmitter Performance Checks....138
Chapter 6: Radio Alignment Procedures....141
6.1 Navigating the Tuner Program....141
6.2 Radio Information....143
6.3 Transmitter Alignments....143

6.3.1 Aligning PA Bias 1 143
6.3.2 Aligning PA Bias 2 145
6.3.3 Aligning PA Bias 3 146
6.3.4 Aligning the Reference Oscillator 148
6.3.4.1 Setting Up the Communication Analyzer for Reference Oscillator Alignment 149
6.3.5 Aligning the Power Detector Calibration 149
6.3.6 Aligning the Transmit Power Characterization 150
6.3.7 Aligning the Transmit Current Limit 152
6.3.7.1 Aligning the Transmit Voltage Limit 153
6.3.8 Tx Deviation Balance (Compensation) 154
6.3.9 Performance Testing 156
6.3.9.1 Bit Error Rate (BER) Test 156
6.3.9.2 Transmitter Test Pattern 157

Chapter 7: Encryption 159

7.1 Motorola Advanced Crypto Engine Secure Options 159
7.1.1 Secure Key Retention 159
7.1.2 Securing Dispatch Operation 160
7.1.3 Secure Emergency Operation 160
7.2 Loading an Encryption Key 160
7.3 Advanced Secure Operation 161
7.3.1 Multikey Operation 161
7.4 Erasing Keys 162
7.5 Erasing All Keys 162
7.6 Over-the-Air Rekeying 163

Chapter 8: Disassembly/Reassembly Procedures 164

8.1 Replacement Procedures 164
8.1.1 Required Tools and Supplies 164
8.1.2 O2 Control Head Disassembly 165
8.1.3 O2 Control Head Reassembly 167
8.1.4 O3 Control Head Disassembly 169
8.1.5 O3 Control Head Reassembly 173
8.1.6 O5 Control Head Disassembly 173
8.1.7 O5 Control Head Reassembly 174
8.1.8 O7 Control Head Disassembly 176
8.1.9 O7 Control Head Reassembly 178
8.1.10 O9 Control Head Disassembly 180
8.1.11 O9 Control Head Reassembly 184
8.1.12 O9 Universal Relay Controller Disassembly 190

8.1.13 O9 Universal Relay Controller Reassembly....192
8.1.13.1 Chassis Thermal Pad Replacement....193
8.1.14 O9 Universal Relay Controller Cable Assembly.... 194
8.1.14.1 Power Cable....194
8.1.14.2 Ground Cable....194
8.1.14.3 Wires....195
8.1.14.4 O9 to URC Cable....196
8.1.15 Disassembling the E5 Control Head....197
8.1.16 Reassembling the E5 Control Head....202
8.1.17 Transceiver Interface Board Disassembly/Reassembly....209
8.1.17.1 Mid Power Model Disassembly....209
8.1.17.2 High-Power Model Disassembly....210
8.1.17.3 TIB Model Reassembly....211
8.1.18 Radio Disassembly....212
8.1.18.1 APX 5500/APX 6500/APX 7500/APX 6500Li Mid Power Models....213
8.1.18.2 Disassembling the Radio....224
8.1.18.3 High Power Models....232
8.1.18.4 Disassembling the O2 Control Head....239
8.1.18.5 Disassembling the O5 Control Head....242
8.1.18.6 Disassembling the O7 Control Head....245
8.1.18.7 TIB Disassembly....248
8.1.19 Radio Reassembly....250
8.1.19.1 APX 5500/APX 6500/APX 7500/APX 6500Li Mid Power Models....250
8.1.19.2 Mid Power Models....264
8.1.19.3 High Power Models....273
8.1.19.4 Reassembling the O2 Control Head....283
8.1.19.5 Reassembling the O5 Control Head....286
8.1.19.6 Reassembling the O7 Control Head....289
8.1.19.7 TIB Reassembly....290
8.2 Chassis Thermal Pad Replacement Procedure....293
8.2.1 Mid Power Models....293
8.2.2 High Power Models....295
8.3 Fastener Torque Chart....296
Chapter 9: System Level Diagnostics and Basic Radio Analysis....298
9.1 External Connectors....298
9.1.1 J1 – Mobile Microphone Port (MMP)....298
9.1.2 J2 Mid Power Transceiver – Data and Audio Rear Interface....299
9.1.3 J100 CHUC – Mobile Accessory Port Interface for APX 7500....302
9.1.4 J200 CHUC – Power and Audio Interface....304

9.1.5 J300 CHUC – Controller Area Network (CAN) Interface..... 305
9.1.6 J400 CHUC – VIP and DEK Interface.....306
9.1.7 J500 CHIB – USB HOST Interface..... 307
9.1.8 J600 TIB – Data and Audio Interface.....308
9.1.9 J700 TIB – Mobile Microphone Port (MMP).....310
9.1.10 J800 TIB – Controller Area Network (CAN) Interface..... 311
9.1.11 I/O Disclaimer..... 312
9.2 Microphone Bias.....312
9.3 Audio PA Out Bias.....312
9.4 Controller Troubleshooting..... 312
Chapter 10: Functional Block Diagrams and Connectors.....315
10.1 APX Mobile Radio Transceiver Functional Block Diagram.....316
10.2 O3 Dash and Remote Control Head Functional Block Diagram.....317
10.3 O2, O5, and O7 Dash and Remote Control Head Functional Block Diagram..... 318
10.4 E5 Dash and Remote Control Head Functional Block Diagram..... 319
10.5 O9 Remote Control Head Functional Block Diagram..... 320
10.6 O2 Control Head Functional Block Diagram.....321
10.7 O3 Control Head Functional Block Diagram.....322
10.8 O5 Control Head Functional Block Diagram.....323
10.9 O7 Control Head Functional Block Diagram.....324
10.10 O9 Control Head Functional Block Diagram.....325
10.11 O5 Control Head Interface Board (CHIB) Functional Block Diagram..... 326
10.12 O2, O7, and E5 Control Head Interface Board (CHIB) Functional Block Diagram.....327
10.13 APX Mobile Radio Transceiver Interface Board (TIB) Functional Block Diagram..... 329
10.14 O3 Radio Connector Locations.....331
10.14.1 Mid Power Only.....331
10.14.2 High Power Only.....333
10.15 O5 Radio Connector Locations.....334
10.15.1 Mid Power Only.....334
10.15.2 High Power Only.....335
10.16 E5 Radio Connector Locations.....336
10.16.1 Mid Power Only.....336
10.16.2 High Power Only.....337
10.17 O9 Transceiver Interface..... 337
Chapter 11: Exploded Views and Parts Lists..... 339
11.1 O2 Control Head Exploded View and Parts List.....340
11.2 O3 Control Head Exploded View and Parts List.....342
11.3 O5 Control Head Exploded View and Parts List.....343
11.4 O7 Control Head Exploded View and Parts List.....345

11.5 O9 Control Head Exploded View and Parts List..... 347
11.6 E5 Control Head Exploded View and Parts List..... 349
11.7 O2 CHIB and CHUC Exploded View and Parts List..... 351
11.8 O5 CHIB and CHUC Exploded View and Parts List..... 352
11.9 O7 CHIB and CHUC Exploded View and Parts List..... 354
11.10 E5 CHIB and CHUC Exploded View and Parts List.....356
11.11 Transceiver Interface Board (TIB) Exploded View and Parts List.....357
11.12 APX 2500/4500/4500Li/1500 O2 Dash Mount Radio Exploded View and Parts List..... 358
11.13 APX 2500 O3 Radio Exploded View and Parts List.....360
11.14 APX 2500 O7 Dash Mount Radio Exploded View and Parts List..... 362
11.15 APX 5500/6500/7500/6500 Li O2 Dash Mount Radio Exploded View and Parts List..... 364
11.16 APX 5500/6500/7500/6500 Li O3 Radio Exploded View and Parts List.....366
11.17 APX 5500/6500/7500/6500 Li O5 Dash Mount Radio Exploded View and Parts List..... 368
11.18 APX 5500/6500/7500/6500 Li E5 Dash Mount Radio Exploded View and Parts List.....370
11.19 APX 2500/4500 O5 Dash Mount Radio Exploded View and Parts List..... 372
11.20 APX 2500/4500 E5 Dash Mount Radio Exploded View and Parts List.....374
11.21 APX 5500/6500/7500/6500 Li O7 Dash Mount Radio Exploded View and Parts List..... 376
11.22 APX 5500/6500/7500/6500 Li 100 W Remote Mount Radio Exploded View and Parts List..... 378
11.23 Universal Relay Controller Exploded View and Parts List..... 380
Appendix A: Accessories.....383
Appendix B: Replacement Parts and Kits..... 384
Appendix C: Replacement Parts Ordering..... 385
Appendix D: Motorola Solutions Service Centers..... 386
Appendix E: Warranty, Service, and Technical Support..... 387
E.1 Service Information..... 387
E.2 Service Information for APAC..... 388
Appendix F: Maritime Radio Use in the VHF Frequency Range..... 391
F.1 Emergency Channel..... 391
F.2 Non-Commercial Call Channel..... 391
F.3 Operating Frequency Requirements..... 392

List of Figures

Figure 1: O2 Control Head..... 35
Figure 2: O3 Control Head..... 36
Figure 3: O5 Control Head..... 37
Figure 4: E5 Control Head.....38
Figure 5: O7 Control Head..... 39
Figure 6: O9 Control Head..... 40
Figure 7: Mobile Controller Block Diagram for APX 5500/6500/7500/6500Li.....68
Figure 8: Mobile Controller Block Diagram for APX 2500/4500/4500Li/1500.....69
Figure 9: APX 5500/6500/6500Li/7500 Controller Overlay (Side 1).....69
Figure 10: APX 5500/6500/6500Li/7500 Controller Overlay (Side 2).....70
Figure 11: APX 2500/4500/4500Li/1500 Controller Overlay (Side 1).....71
Figure 12: APX 2500/4500/4500Li/1500 Controller Overlay (Side 2).....72
Figure 13: Voltage Distribution/Power On/Off Diagram for APX 5500/6500/7500/6500Li.....74
Figure 14: Voltage Distribution/Power On/Off Diagram for APX 2500/4500/4500Li/1500.....74
Figure 15: Audio Receive Path in APX mobile radio Transceiver..... 77
Figure 16: Audio Transmit Path in APX mobile radio Transceiver..... 77
Figure 17: Key Retention Graph.....78
Figure 18: GPS Architecture.....79
Figure 19: Dash-Mount Configuration..... 80
Figure 20: Remote-Mount Configuration for APX 5500/6500/7500/6500Li.....80
Figure 21: Remote-Mount Configuration for APX 2500/4500.....81
Figure 22: Option PCB with Memory and 3-Day Secure Key (MHLN6999_S).....83
Figure 23: O3 Remote Mount Configuration.....89
Figure 24: O2 and O7 Remote Mount Configuration.....90
Figure 25: O9 and Transceiver Interface Block Diagram..... 91
Figure 26: E5 and Transceiver Interface Block Diagram.....92
Figure 27: Single O3 Control Head + VIPS.....93
Figure 28: Single O2, O5, O7, O9 and E5 Control Head + VIPS..... 94
Figure 29: Multiple O5/E5 Control Heads + VIPS.....95
Figure 30: Single Control Head + VIPS.....96
Figure 31: CAN Termination Section.....97
Figure 32: Single O3 Control Head + DEK + VIPS.....98
Figure 33: Single O5 Control Head + DEK + VIPS.....98
Figure 34: Multiple Control Heads + DEK +VIPS..... 99
Figure 35: Two node system with CAN terminations enabled.....100
Figure 36: CAN Termination Section.....100

Figure 37: O5 Control Head Interface Board (CHIB)....101
Figure 38: E5 Control Head Interface Board - CHIB....102
Figure 39: O2 and O7 Control Head Interface Board - CHIB....102
Figure 40: Control Head Universal Connector (CHUC)....104
Figure 41: HUB-Box Block Diagram....105
Figure 42: Transceiver Interface Board (TIB)....106
Figure 43: Configuration of the Dual Band Frequency Generation Unit for APX 5500/6500/7500/6500Li....114
Figure 44: Configuration of APX 2500/4500/4500Li/1500 Frequency Generation Unit....115
Figure 45: Performance Checks Test Setup....124
Figure 46: O2 Control Head....128
Figure 47: O3 Control Head....130
Figure 48: O5 Control Head....131
Figure 49: E5 Control Head....133
Figure 50: O7 Control Head....134
Figure 51: O9 Control Head....136
Figure 52: Radio Alignment Test Setup for Mobile Radios....141
Figure 53: VHF/700-800 MHz Tuner Main Menu....142
Figure 54: Radio Information Screen....143
Figure 55: PA Bias 1 Alignment Screen....144
Figure 56: PA Bias 2 Alignment Screen....146
Figure 57: PA Bias 3 Alignment Screen....147
Figure 58: Reference Oscillator Window....148
Figure 59: Power Detection Calibration Alignment Screen....150
Figure 60: Tx Power Characterization Alignment Screen....151
Figure 61: Tx Current Limit Alignment Screen....153
Figure 62: Tx Voltage Limit Alignment Screen....154
Figure 63: Tx Deviation Balance (Compensation) Alignment Screen....155
Figure 64: Bit Error Rate Screen....156
Figure 65: Transmitter Test Pattern Screen....158
Figure 66: PCB Screw Sequence....165
Figure 67: Removing The Encoder Assembly....166
Figure 68: Speaker Retainer Alignment....167
Figure 69: PCB Screw Alignment....168
Figure 70: Cable Lock Detachment....169
Figure 71: Front Housing and Back Housing Detachment....170
Figure 72: Separate Front Housing and Back Housing....171
Figure 73: PCB Detachment....172
Figure 74: Disconnecting the 2-pin Connector....172
Figure 75: Control Head Screw Sequence....173

Figure 76: Main PCB Screw Alignment..... 175
Figure 77: Main PCB Retention Screw Sequence.....176
Figure 78: Removing the Encoder Assembly..... 177
Figure 79: Bluetooth PCB Retention Screw Sequence..... 177
Figure 80: Bluetooth PCB Retention Screw Alignment..... 178
Figure 81: Main PCB Retention Screw Alignment.....179
Figure 82: Control Head Screw Sequence.....180
Figure 83: Separated Front and Back Housing Assemblies.....181
Figure 84: Location of Flex Connectors.....181
Figure 85: Self-Tapping Screws Sequence.....182
Figure 86: Disconnect Frequency Flex.....182
Figure 87: Self-Tapping Screws Sequence.....183
Figure 88: Self-Tapping Screws Sequence.....184
Figure 89: Assemble Flexes Into Front Housing..... 185
Figure 90: Assemble Keypads and Indicator Light Guide..... 186
Figure 91: Assemble Front Keypad PCB and LCD Display.....186
Figure 92: Orientation Proof Features at the Housing.....187
Figure 93: Location of Alignment Pins.....187
Figure 94: Align LCD Flex and Front Keypad Flex.....188
Figure 95: Location of Guiding Pins..... 189
Figure 96: Cable Lock Detachment.....190
Figure 97: Universal Relay Controller Screw Sequence..... 191
Figure 98: Universal Relay Controller Wire Connections..... 191
Figure 99: Cable Gland Assembly with Gasket.....193
Figure 100: Wires Installation.....195
Figure 101: Wire Installation with Black Stick.....196
Figure 102: O9 to URC Cable Installation..... 197
Figure 103: Main PCB Retainer Screws.....197
Figure 104: Main PCB Retainer.....198
Figure 105: Main PCB..... 198
Figure 106: Color Display Module..... 199
Figure 107: Removing Hex Nut..... 199
Figure 108: Emergency Button [20] and Emergency Button Retainer [21].....199
Figure 109: Home Button [14] and Home Button Retainer [15].....200
Figure 110: Navigation Button [16] and Navigation Button Retainer [17].....200
Figure 111: Menu Button [18] and Menu Button Retainer [19].....200
Figure 112: Programmable Button [12] and Programmable Button Retainer [13].....201
Figure 113: Power Button and Indicator Lights assembly [9][10][11]..... 201
Figure 114: Volume Assembly Potentiometer..... 201

Figure 115: Volume Assembly Potentiometer..... 202
Figure 116: Installing 3 Wave Washers.....202
Figure 117: Fastening Hex Nut.....203
Figure 118: Torque Washer.....203
Figure 119: Installing Volume and Frequency Knobs.....204
Figure 120: Power Button and Indicator Lights assembly [9][10][11]..... 204
Figure 121: Programmable Button [12] and Programmable Button Retainer [13].....205
Figure 122: Menu Button [18] and Menu Button Retainer [19].....205
Figure 123: Navigation Button [16] and Navigation Button Retainer [17].....205
Figure 124: Home Button [14] and Home Button Retainer [15].....206
Figure 125: Emergency Button [20] and Emergency Button Retainer [21].....206
Figure 126: Color Display Module..... 206
Figure 127: Main Board PCB.....207
Figure 128: Volume, Frequency and Color Display Module Flex Assemblies.....207
Figure 129: Frequency Assembly Flex.....207
Figure 130: Color Display Module Flex..... 208
Figure 131: Volume Assembly Flex.....208
Figure 132: Main PCB Retainer.....208
Figure 133: Main PCB Retainer Screws.....209
Figure 134: Front Panel Disassembly for Mid Power Model..... 210
Figure 135: Front Panel Disassembly for High-Power Model.....211
Figure 136: TUC Seal Placement.....211
Figure 137: Front Panel Reassembly for Mid Power Model.....212
Figure 138: Front Panel Reassembly for High-Power Model..... 212
Figure 139: Removing the Control Head Screws..... 213
Figure 140: Removing the Control Head/TIB..... 214
Figure 141: Removing the Control Head Flex..... 215
Figure 142: Removing the Option Board Screws..... 216
Figure 143: Removing the Option Board.....216
Figure 144: Removing the Controller Cover Screws..... 217
Figure 145: Lifting the Controller Cover.....217
Figure 146: Disconnecting the GPS Cable.....218
Figure 147: Removing the J2 Rear Accessory Flex from the Controller Board.....218
Figure 148: Removing the Controller Board.....219
Figure 149: Removing the RF Cover Screws.....219
Figure 150: Lifting the RF Cover..... 220
Figure 151: Removing the PA Screws.....220
Figure 152: Removing the RF/DC Retention Clips.....221
Figure 153: Removing the RF Board.....221

Figure 154: Removing the J2 Rear Accessory Connector Internal Screw..... 222
Figure 155: Removing the J2 Rear Accessory Connector External Screws..... 222
Figure 156: Removing the J2 Rear Accessory Connector..... 223
Figure 157: Removing the GPS Cable Nut.....223
Figure 158: Removing the GPS Cable..... 224
Figure 159: Removing the Bottom Cover Screws..... 225
Figure 160: Removing the Bottom Cover..... 225
Figure 161: Disconnecting the GPS Cable.....226
Figure 162: Disconnecting the Rear Accessory Flex.....226
Figure 163: Removing the Controller Board.....227
Figure 164: Removing the Top Cover Screws.....227
Figure 165: Removing the RF Cover.....228
Figure 166: Removing the PA Screws.....228
Figure 167: Removing the RF/DC Retention Clips.....229
Figure 168: Removing the RF Board.....229
Figure 169: Removing the Rear Accessory Connector screws.....230
Figure 170: Removing the Rear Connector Flex.....230
Figure 171: Removing the GPS SMA Connector..... 231
Figure 172: Removing the GPS Cable..... 231
Figure 173: Removing the Transceiver Interface Board Screws.....232
Figure 174: Removing the Transceiver Interface Board Assembly..... 232
Figure 175: Removing the Flex (Transceiver Interface Board Connector).....233
Figure 176: Removing the Option Board.....234
Figure 177: Removing the Controller Cover Screws..... 234
Figure 178: Lifting the Controller Cover.....235
Figure 179: Controller Cover Removed.....235
Figure 180: Removing the Controller Board.....236
Figure 181: Removing the RF Cover Screws.....236
Figure 182: Lifting the RF Cover..... 237
Figure 183: Removing the PA Screws (MP/HP Configuration Shown)..... 237
Figure 184: Removing the RF/DC Retention Clips.....237
Figure 185: Pushing Up the Main Board..... 238
Figure 186: Removing the Pivot Pin Clip.....238
Figure 187: Removing the Control Head Screws..... 239
Figure 188: Removing the Control Head.....240
Figure 189: Disconnecting the Transceiver Flex from the Front Housing Assembly.....241
Figure 190: Removing the Back Housing Assembly..... 241
Figure 191: Removing the Transceiver Flex.....242
Figure 192: Removing the Control Head Screws..... 243

Figure 193: Removing the Control Head/TIB..... 243
Figure 194: Removing the Control Head Flex..... 244
Figure 195: Removing the Transceiver Screws.....245
Figure 196: Removing the Control Head.....246
Figure 197: Disconnecting the Transceiver Flex from the Transceiver..... 247
Figure 198: Removing the Transceiver Flex.....247
Figure 199: Removing the TIB Screws.....248
Figure 200: Laying down the TIB.....248
Figure 201: Disconnecting Remote Mount Flex from the Transceiver..... 249
Figure 202: Separating I-Seal from TIB.....249
Figure 203: Inspecting the Chassis Shield Gasketing and Thermal Pads.....250
Figure 204: Installing the GPS Nut and Torque Nut.....251
Figure 205: Inserting Rear Accessory Flex..... 251
Figure 206: Installing Rear Accessory Connector Screws..... 252
Figure 207: Installing Accessory Flex Screw.....252
Figure 208: Applying Thermal Grease to RF Board Heat Sinks.....253
Figure 209: Ensuring RF and DC Connector Seals are properly seated.....253
Figure 210: Inserting RF Board into Chassis.....254
Figure 211: Inserting RF/DC Retention Clips..... 254
Figure 212: Installing PA Screws.....255
Figure 213: Inspecting Thermal Pad and Installing RF Cover Main Seal.....255
Figure 214: Securing RF Cover to Chassis.....255
Figure 215: Securing the RF Cover to the Chassis.....256
Figure 216: Installing the Controller Board into the Chassis..... 256
Figure 217: Installing the GPS Connector to the Controller Board.....257
Figure 218: Install the Accessory Flex Connector to the Controller Board.....257
Figure 219: Applying Thermal Grease to the Controller Cover..... 258
Figure 220: Inspecting and installing Controller Cover Seal onto Controller Cover..... 258
Figure 221: Placing Controller Cover onto Chassis.....259
Figure 222: Securing the Controller Cover Screws..... 259
Figure 223: Installing the Option Board.....260
Figure 224: Installing the Option Board Screws..... 260
Figure 225: Installing the WLAN Port Plug.....260
Figure 226: Installing Flex into Controller PCB.....261
Figure 227: Aligning frame seal to TIB..... 262
Figure 228: Installing Control Head/TIB Flex to Control Head/TIB.....263
Figure 229: Aligning Control Head/TIB front of chassis, and Installing the Control Head/TIB screws. 264
Figure 230: Inspecting the Chassis Shield Gasketing and Thermal Pads.....265
Figure 231: Inserting GPS cable..... 265

Figure 232: Inserting Rear Accessory Flex..... 266
Figure 233: Installing the Rear Accessory Connector Screws..... 266
Figure 234: Applying the Thermal Grease to RF Board Heat Sinks.....267
Figure 235: Ensuring that the RF and DC Connector Seals are Properly Seated.....267
Figure 236: Inserting RF Board into the Chassis.....268
Figure 237: Inserting the RF and DC Retention Clips..... 268
Figure 238: Installing the PA Screws.....269
Figure 239: Inspecting and Installing the RF Cover Seal..... 269
Figure 240: Placing the RF Cover onto Chassis..... 270
Figure 241: Installing Screws onto the RF Cover/Chassis..... 270
Figure 242: Installing Controller Board into Chassis..... 271
Figure 243: Installing Accessory Flex Connector to the Controller Board..... 271
Figure 244: Installing GPS Connector to the Controller Board.....271
Figure 245: Inspecting and installing Bottom Cover Seal onto the Bottom Cover.....272
Figure 246: Placing Controller Cover on the Chassis.....272
Figure 247: Placing the Controller Cover Screws.....273
Figure 248: Inspecting the Chassis Shield Gasketing and Thermal Pads.....274
Figure 249: Inserting the RF Board into the Chassis.....274
Figure 250: Inserting the RF/DC Retention Clips (Before)..... 275
Figure 251: Inserting the RF/DC Retention Clips (After)..... 275
Figure 252: Installing the PA Screws (HP/MP radio shown)..... 276
Figure 253: Inspecting the Thermal Pad and Installing the Cover Main Seal.....277
Figure 254: RF Screw Locations..... 278
Figure 255: Torque Sequence.....278
Figure 256: Inserting the Controller Board in the Chassis.....279
Figure 257: Applying Thermal Grease to the Controller Board..... 279
Figure 258: Inserting the GPS Connector to the Controller Board..... 280
Figure 259: Inspect and Install Controller Cover Seal onto the Controller Cover.....280
Figure 260: Place the Controller Cover onto the Chassis..... 281
Figure 261: Securing the Controller Cover to Chassis..... 281
Figure 262: Installing the Option Board.....282
Figure 263: Attaching the Flex Edge Card Connector.....282
Figure 264: Installing the Control Head/TIB..... 283
Figure 265: Installing the Transceiver Flex onto the Transceiver.....284
Figure 266: Installing the Back Housing Assembly onto the Transceiver.....284
Figure 267: Installing the Transceiver Flex onto the Front Housing Assembly..... 285
Figure 268: Attaching the Front Housing Assembly to the Back Housing Assembly..... 285
Figure 269: Attaching the Control Head Screws..... 286
Figure 270: Installing Flex into the Controller PCB.....287

Figure 271: Installing Control Head/TIB Flex to the Control Head/TIB....288
Figure 272: Aligning Control Head/TIB Front of Chassis, and Installing the Control Head/TIB Screws....288
Figure 273: Installing the Transceiver Flex onto the Control Head....289
Figure 274: Attaching the I-seal to the Control Head....289
Figure 275: Attaching the Control Head to the Transceiver....290
Figure 276: Attaching the Transceiver Screws....290
Figure 277: Reinstalling TIB Flex/Remote Mount Flex....291
Figure 278: Aligning and placing the I-Seal....291
Figure 279: Aligning and Placing TIB on Transceiver....292
Figure 280: Installing the TIB screws....292
Figure 281: Chassis Thermal Pad and Grease Locations....293
Figure 282: Chassis Thermal Pad and Grease Locations....295
Figure 283: MMP Connector....298
Figure 284: J2 Rear Accessory Connector....300
Figure 285: J100 Mobile Accessory Port (MAP) Connector....302
Figure 286: J200 Power and Audio Connector....304
Figure 287: J300 Controller Area Network (CAN) Connector on CHIB....305
Figure 288: J400 VIP and DEK Connector....306
Figure 289: J500 USB Host Connector....307
Figure 290: J600 Connector....308
Figure 291: J700 MMP Programming Connector....311
Figure 292: J800 Controller Area Network (CAN) Connector on TIB....311
Figure 293: APX Mobile Radio Transceiver Functional Block Diagram....316
Figure 294: O3 Dash and Remote Control Head Functional Block Diagram....317
Figure 295: O2, O5, and O7 Dash and Remote Control Head Functional Block Diagram....318
Figure 296: E5 Dash and Remote Control Head Functional Block Diagram....319
Figure 297: O9 Remote Control Head Functional Block Diagram....320
Figure 298: O2 Control Head Functional Block Diagram....321
Figure 299: O3 Control Head Functional Block Diagram....322
Figure 300: O5 Control Head Functional Block Diagram....323
Figure 301: O7 Control Head Functional Block Diagram....324
Figure 302: O9 Control Head Functional Block Diagram....325
Figure 303: O5 Control Head Interface Board (CHIB) Functional Block Diagram....326
Figure 304: O2 and O7 Control Head Interface Board (CHIB) Functional Block Diagram....327
Figure 305: E5 Control Head Interface Board (CHIB) Functional Block Diagram....328
Figure 306: APX Mobile Radio Transceiver Interface Board (TIB) Functional Block Diagram....329
Figure 307: APX Mobile Radio Transceiver Interface Board (TIB) Functional Block Diagram Applicable for PMUN1083_Rev D and Onwards....330
Figure 308: O3 Dash-Mount Radio Connector Locations (Mid Power Only)....331

Figure 309: O3 Remote-Mount Radio Connector Locations..... 332
Figure 310: O3 Remote-Mount Radio Connector Locations (High Power Only)..... 333
Figure 311: O5 Dash-Mount Radio Connector Locations (Mid Power Only)..... 334
Figure 312: O5 Remote-Mount Radio Connector Locations (Mid Power Only)..... 335
Figure 313: O5 Remote-Mount Radio Connector Locations (High Power Only)..... 335
Figure 314: E5 Dash-Mount Radio Connector Locations (Mid Power Only)..... 336
Figure 315: E5 Remote-Mount Radio Connector Locations (Mid Power Only)..... 336
Figure 316: E5 Remote-Mount Radio Connector Locations (High Power Only)..... 337
Figure 317: Transceiver Interface Board (TIB), Universal Relay Controller & Control Head View..... 337
Figure 318: Remote-Mount Configuration with 100 W or Higher Power Radio..... 338
Figure 319: O2 Control Head Exploded View..... 340
Figure 320: O3 Control Head Exploded View..... 342
Figure 321: O5 Control Head Exploded View..... 343
Figure 322: O7 Control Head Exploded View..... 345
Figure 323: O9 Control Head Exploded View..... 347
Figure 324: E5 Control Head Exploded View..... 349
Figure 325: O2 CHIB and CHUC Exploded View..... 351
Figure 326: O5 CHIB and CHUC Exploded View..... 352
Figure 327: O7 CHIB and CHUC Exploded View..... 354
Figure 328: E5 CHIB and CHUC Exploded View..... 356
Figure 329: Transceiver Interface Board (TIB) Exploded View..... 357
Figure 330: APX 2500/4500/4500Li/1500 O2 Dash Mount Radio Exploded View..... 358
Figure 331: APX 2500 O3 Radio Exploded View..... 360
Figure 332: APX 2500 O7 Dash Mount Radio Exploded View..... 362
Figure 333: APX 5500/6500/7500/6500 Li O2 Dash Mount Radio Exploded View..... 364
Figure 334: APX 5500/6500/7500/6500 Li O3 Radio Exploded View..... 366
Figure 335: APX 5500/6500/7500/6500 Li O5 Dash Mount Radio Exploded View..... 368
Figure 336: APX 5500/6500/7500/6500 Li E5 Dash Mount Radio Exploded View..... 370
Figure 337: APX 2500/4500 O5 Dash Mount Radio Exploded View..... 372
Figure 338: APX 2500/4500 E5 Dash Mount Radio Exploded View..... 374
Figure 339: APX 5500/6500/7500/6500 Li O7 Dash Mount Radio Exploded View..... 376
Figure 340: APX 5500/6500/7500/6500 Li 100 W Remote Mount Radio Exploded View..... 378
Figure 341: Universal Relay Controller Exploded View..... 380

List of Tables

Table 1: APX Mobile Radios Frequency Ranges and Power Level 31
Table 2: O2 Control Head Basic Features 32
Table 3: O3 Control Head Basic Features 32
Table 4: O5 Control Head Basic Features 33
Table 5: E5 Control Head Basic Features 33
Table 6: O7 Control Head Basic Features 33
Table 7: O9 Control Head Basic Features 34
Table 8: Sales Model Nomenclature 41
Table 9: Sales Models–Description of Symbols 41
Table 10: General (VHF) 42
Table 11: Receiver (VHF) 44
Table 12: Transmitter (VHF) 45
Table 13: General (UHF R1) 46
Table 14: Receiver (UHF R1) 48
Table 15: Transmitter (UHF R1) 49
Table 16: General (UHF R2) 50
Table 17: Receiver (UHF R2) 52
Table 18: Transmitter (UHF R2) 53
Table 19: General (700–800 MHz) 54
Table 20: Receiver (700–800 MHz) 56
Table 21: Transmitter (700–800 MHz) 57
Table 22: General (900 MHz) 58
Table 23: Receiver (900 MHz) 59
Table 24: Transmitter (900 MHz) 60
Table 25: Radio Frequency Bands 64
Table 26: Control Head and CHIB Compatibility 101
Table 27: Front-End Configuration 110
Table 28: Recommended Motorola Solutions Test Equipment 117
Table 29: Wattmeter Plug-In Elements 118
Table 30: Recommended Non-Motorola Solutions Test Equipment 118
Table 31: Service Aids for Mobile Radios 119
Table 32: Recommended Motorola Solutions Tools for APX Mobile Radios 120
Table 33: APX 2500/APX 4500/APX 4500Li/APX 1500 Chassis Eliminator Internal Assemblies 122
Table 34: Recommended Non-Motorola Solutions Tools for APX Mobile Radios 122
Table 35: Mobile Radios Field-Programming Items 123
Table 36: Test-Mode Displays 125

Table 37: Rx Test Frequencies..... 126
Table 38: Tx Test Frequencies..... 127
Table 39: Signaling Types..... 127
Table 40: Receiver Performance Checks..... 137
Table 41: Transmitter Performance Checks..... 138
Table 42: PA Bias 1 Alignment RF Power Amplifier Devices..... 143
Table 43: Power Supply Voltage Settings..... 144
Table 44: PA Bias 1 Alignment Device Bias Current..... 144
Table 45: PA Bias 2 Alignment Amplifier Devices 145
Table 46: Power Supply Voltage Settings..... 145
Table 47: PA Bias 2 Alignment Device Bias Current..... 146
Table 48: PA Bias 3 Alignment Amplifier Devices..... 146
Table 49: Power Supply Voltage Settings..... 147
Table 50: PA Bias 3 Alignment Device Bias Current..... 147
Table 51: Reference Oscillator Alignment..... 149
Table 52: Communication Analyzer Set up..... 149
Table 53: Power Supply Voltage Settings..... 150
Table 54: Power Supply Voltage Settings..... 151
Table 55: Power Supply Voltage Settings..... 152
Table 56: Transmit Current Limit Devices..... 153
Table 57: Bit Error Rate Test Fields..... 156
Table 58: Transmitter Test Pattern Fields..... 157
Table 59: Secure Board Kit..... 159
Table 60: Controller Boards with Programmed Secure Algorithms for APX 5500/6500/7500/6500Li.. 159
Table 61: Controller Boards with Programmed Secure Algorithms for APX 2500..... 159
Table 62: Controller Boards with Programmed Secure Algorithms for APX 4500..... 160
Table 63: Required Tools and Supplies..... 164
Table 64: Number of PA Screws to Install..... 254
Table 65: Number of PA Screws..... 276
Table 66: Chassis Thermal Pad and Grease Part Numbers..... 294
Table 67: Chassis Thermal Pad and Grease Part Numbers..... 295
Table 68: Fastener Torque Chart..... 296
Table 69: MMP Connector Signal Descriptions..... 299
Table 70: J2 Rear Accessory Connector Signal and Voltage Descriptions..... 300
Table 71: J100 Remote Mount Control Head Mobile Accessory Port (MAP)..... 303
Table 72: J200 Power and Audio Connector Pin Functions..... 305
Table 73: J300 Controller Area Network Connector Pin Functions..... 306
Table 74: J400 VIP and DEK Connector Functionality..... 306
Table 75: J500 USB Host Connector..... 307

Table 76: J600 Remote Mount Accessory Connector..... 308
Table 77: J800 Controller Area Network Connector Pin Functions..... 311
Table 78: Controller Troubleshooting Chart..... 312
Table 79: Table of Functional Block Diagrams and Connectors..... 315
Table 80: Table of Exploded Views..... 339
Table 81: O2 Control Head Parts List..... 340
Table 82: O3 Control Head Parts List..... 342
Table 83: O5 Control Head Parts List..... 343
Table 84: O7 Control Head Parts List..... 345
Table 85: O9 Control Head Parts List..... 347
Table 86: E5 Control Head Parts List..... 349
Table 87: O2 CHIB and CHUC Parts List..... 351
Table 88: O5 CHIB and CHUC Parts List..... 353
Table 89: O7 CHIB and CHUC Parts List..... 354
Table 90: E5 CHIB and CHUC Parts List..... 356
Table 91: Transceiver Interface Board (TIB) Parts List..... 357
Table 92: APX 2500/4500/4500Li/1500 O2 Dash Mount Radio Parts List..... 358
Table 93: APX 2500 O3 Radio Parts List..... 360
Table 94: APX 2500 O7 Dash Mount Radio Parts List..... 362
Table 95: APX 5500/6500/7500/6500 Li O2 Dash Mount Radio Parts List..... 364
Table 96: APX 5500/6500/7500/6500 Li O3 Radio Parts List..... 366
Table 97: APX 5500/6500/7500/6500 Li O5 Dash Mount Radio Parts List..... 368
Table 98: APX 5500/6500/7500/6500 Li E5 Dash Mount Radio Parts List..... 370
Table 99: APX 2500/4500 O5 Dash Mount Radio Parts List..... 372
Table 100: APX 2500/4500 E5 Dash Mount Radio Parts List..... 374
Table 101: APX 5500/6500/7500/6500 Li O7 Dash Mount Radio Parts List..... 376
Table 102: APX 5500/6500/7500/6500 Li 100 W Remote Mount Radio Parts List..... 378
Table 103: Universal Relay Controller Parts List..... 381
Table 104: APX 5500/6500/7500/6500 Li 100 W Power RF Board..... 382
Table 105: APX 2500/4500/4500Li/1500 Low/Mid Power Controller Board..... 382
Table 106: North America Motorola Solutions Offices..... 386
Table 107: Latin America Motorola Solutions Offices..... 386
Table 108: Service Information – Telephone Numbers and Addresses of the Asia and Pacific Motorola Solutions Centers..... 388
Table 109: VHF Marine Channel List..... 392

Foreword

This manual includes all the information necessary to maintain peak product performance and maximum working time, using levels 1 and 2 maintenance procedures.

CAUTION: These servicing instructions are for the use of qualified personnel only. To reduce the risk of electric shock, do not service parts other than those contained in the Operating Instructions unless you are qualified to do so. Refer all servicing to qualified service personnel.

Product Safety and RF Exposure Compliance

CAUTION: This radio is restricted to occupational use only to satisfy FCC RF energy exposure requirements. Before using this product, read the Product Safety and RF Exposure booklet enclosed with your radio which contains important operating instructions for safe usage and RF energy awareness and control for compliance with applicable standards and regulations.

For a list of Motorola Solutions-approved antennas, batteries, and other accessories, visit http://www.motorolasolutions.com

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The European Union's WEEE directive and the UK's WEEE regulation require that products sold into EU countries and the UK must have the crossed-out wheelie bin label on the product (or the package in some cases). As defined by the WEEE directive, this crossed-out wheelie bin label means that customers and end-users in EU and UK countries should not dispose of electronic and electrical equipment or accessories in household waste.

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Disclaimer

Please note that certain features, facilities, and capabilities described in this document may not be applicable to or licensed for use on a specific system, or may be dependent upon the characteristics of a specific mobile subscriber unit or configuration of certain parameters. Please refer to your Motorola Solutions contact for further information.

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Document History

The following major changes have been implemented in this manual since the previous edition:

Version	Description	Date
6875964M01-A	Initial release.	October 2009
6875964M01-B	Added O9 Control Head information.	June 2010
6875964M01-C	Added APX 6500, UHF R1 and 700–800 MHz,UHF R2, 700–800 model charts.	December 2010
6875964M01-D	Added: • UHF R2, 700–800 model charts • APX 5500, UHF, and VHF model charts	September 2011
6875964M01-E	Updated model charts.	December 2011
6875964M01-F	Added APX 6500Li model charts.	January 2012
6875964M01-G	Added O2 and O7 Control Head.	June 2012
6875964M01-H	Added APX 2500/4500 World Wide Mobile radio information.	November 2012
6875964M01-J	Added: • APX 2500/4500 U1 and U2 information • APX 4500Li information • New service kit part number for O3 • Control Head, in table 11-3	June 2013
6875964M01-K	Added 900MHz band for APX 4500 radio.	November 2013
6875964M01-LA	Added: • APX 1500 radio information • O5 Control Head WWM changes	April 2015
6875964M01-LB	Updated Top Pursuit Knob Part Number in O9 Control Head Part List.	November 2016
6875964M01-LC	Added Thermal Pad Replacement procedure for O9 Universal Controller.	January 2018
6875964M01-LD	• Compliance with the new Motorola Solutions design standard. • Added E5 Control Head information. • Updated Aeroflex 3920 information.	June 2020
6875964M01-LE	Updated Parts List for O3 Control head	July 2020
6875964M01-LF	• Added Control Head and CHIB Compatibility. • Updated J500 CHIB – USB HOST Interface on page 307	May 2021

Version	Description	Date
	• Updated O2, O7, and E5 Control Head Interface Board (CHIB) Functional Block Diagram on page 327 • Updated O2 CHIB and CHUC Parts List. • Updated O7 CHIB and CHUC Exploded View and Parts List on page 354	
6875964M01-LG	• Updated Radio Description on page 31 • Updated Control Head Interface Board (CHIB) on page 100. • Updated J500 CHIB – USB HOST Interface on page 307 • O2, O7, and E5 Control Head Interface Board (CHIB) Functional Block Diagram on page 327 • Updated O2 CHIB and CHUC Exploded View and Parts List on page 351. • Updated O5 CHIB and CHUC Exploded View and Parts List on page 352 • Updated O7 CHIB and CHUC Exploded View and Parts List on page 354. • Updated E5 CHIB and CHUC Exploded View and Parts List on page 356. • Removed Figure for E5, O2, and O7 Common Control Head Interface Board - CHIB (PMLN8045B or later revision).	December 2022
6875964M01-LH	• General Overview on page 64 • Power Management on page 86 • Audio Section on page 103. • Power Section on page 103. • APX Mobile Radio Transceiver Interface Board (TIB) Functional Block Diagram on page 329. • O2 Control Head Test Mode on page 128. • E5 Control Head Test Mode on page 132. • O7 Control Head Test Mode on page 133. • O2/O3/O5/E5/O7/O9 Remote-Mount on page 92. • O2 CHIB and CHUC Exploded View and Parts List on page 351. • O7 CHIB and CHUC Exploded View and Parts List on page 354.	June 2023

Notations Used in This Manual

Throughout the text in this publication, you will notice the use of warning, caution, and notice notations. These notations are used to emphasize that safety hazards exist, and due care must be taken and observed.

WARNING: WARNING indicates a potentially hazardous situation, which, if not avoided, could result in death or injury.

CAUTION: CAUTION indicates a potentially hazardous situation, which, if not avoided, might result in equipment damage.

NOTE: NOTICE indicates an operational procedure, practice, or condition that is essential to emphasize.

Related Publications

The following list contains part numbers and titles of related publications.

- 6875963M01, *ASTRO APX Mobile Radios And O3, O5, O9 & E5 Detailed Service Manual*
- 68012006086, *ASTRO APX Mobile Radios And O2 & O7 Detailed Service Manual*
- 68012006035, *ASTRO APX Mobile Radio O2 Control Head User Guide*
- 6875946M01, *ASTRO APX Mobile Radio O3 Control Head User Guide*
- 6875947M01, *ASTRO APX Mobile Radio O5 Control Head User Guide*
- 68012006034, *ASTRO APX Mobile Radio O7 Control Head User Guide*
- MN006147A01, *ASTRO APX Mobile Radio E5 Control Head User Guide*
- 68007024014, *ASTRO APX Mobile Radio O9 Control Head User Guide*
- 6878215A01, *ASTRO APX Mobiles O2, O3, O5, E5, O7 & O9 Control Head Installation Manual*
- 6881095C99, *Product Safety and RF Energy Exposure Booklet for Mobile Two-Way Radios*
- 6881095C44, *CPS Programming Installation Guide*

Commercial Warranty

Limited Warranty

For information on warranty terms, see the Support page at https://www.motorolasolutions.com.

I. What This Warranty Covers And For How Long

Motorola Solutions Inc. ("Motorola Solutions") warrants the Motorola Solutions manufactured Communication Products listed below ("Product") against defects in material and workmanship under normal use and service for a period of time from the date of purchase as scheduled below:

Mobile Radios	One Year
Product Accessories	One Year

The radios additionally ship with a standard 1-year Repair Service Advantage (RSA) (for U.S. customers) or 1-year Extended Warranty (for Canada customers). However, at the time of order, you may choose to omit these warranties. For more RSA or Extended Warranty information, please refer to the price pages.

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This warranty gives specific legal rights, and there may be other rights which may vary from state to state.

IV. How To Get Warranty Service

You must provide proof of purchase (bearing the date of purchase and Product item serial number) in order to receive warranty service and, also, deliver or send the Product item, transportation, and insurance prepaid, to an authorized warranty service location.

Warranty service will be provided by Motorola Solutions through one of its authorized warranty service locations. If you first contact the company which sold you the Product, it can facilitate your obtaining warranty service.

You can also call Motorola Solutions at 1-800-927-2744 US/Canada.

V. What This Warranty Does Not Cover

This warranty does not cover the following conditions:

- Defects or damage resulting from use of the Product in other than its normal and customary manner.
- Defects or damage from misuse, accident, water, or neglect.
- Defects or damage from improper testing, operation, maintenance, installation, alteration, modification, or adjustment.
- Breakage or damage to antennas unless caused directly by defects in material workmanship.
- A Product subjected to unauthorized Product modifications, disassemblies or repairs (including, without limitation, the addition to the Product of non-Motorola Solutions supplied equipment) which adversely affect performance of the Product or interfere with Motorola Solutions normal warranty inspection and testing of the Product to verify any warranty claim.
- Product which has had the serial number removed or made illegible.
- Rechargeable batteries if:
  - Any of the seals on the battery enclosure of cells are broken or show evidence of tampering.
  - The damage or defect is caused by charging or using the battery in equipment or service other than the Product for which it is specified.
- Freight costs to the repair depot.
- A Product which, due to illegal or unauthorized alteration of the software/firmware in the Product, does not function in accordance with Motorola Solutions published specifications or the FCC type acceptance labeling in effect for the Product at the time the Product was initially distributed from Motorola Solutions.
- Scratches or other cosmetic damage to Product surfaces that does not affect the operation of the Product.
- Normal and customary wear and tear.

WARNING: The circuitry found on the control head and its associated interface boards is designed to function "as-is". Any attempt at modifying or altering the circuitry would void the warranty, and/or could result in radio malfunction or hazardous conditions for the radio and its associated vehicle.

VI. Patent And Software Provisions

Motorola Solutions will defend, at its own expense, any suit brought against the end user purchaser to the extent that it is based on a claim that the Product or parts infringe a United States patent, and Motorola Solutions will pay those costs and damages finally awarded against the end user purchaser in any such suit which are attributable to any such claim.

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- Motorola Solutions will have sole control of the defense of such suit and all negotiations for its settlement or compromise.
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VII. Governing Law

This Warranty is governed by the laws of the State of Illinois, USA.

Chapter 1

Introduction

This chapter describes the two-way mobile radio.

1.1 Radio Description

The ASTRO APX mobile radios are Motorola Solutions newest two-way mobile radio designed for your organization's most demanding needs.

These radios are available in the following frequencies and power levels.

Table 1: APX Mobile Radios Frequency Ranges and Power Level

Frequency Band	Bandwidth	Power Level		
		APX 7500/APX 6500/APX 6500Li/APX 5500	APX 4500/APX 2500/APX 1500	APX 4500Li
VHF	136–174 MHz	10–50 W variable	1–50 W variable	1–25 W variable
VHF 100W	136–174 MHz	25–100 W variable	N/A	N/A
UHF Range 1	380–470 MHz	10–40 W variable	1–40 W variable	1–25 W variable
UHF Range 1 100 W	380–470 MHz	25–100 W variable	N/A	N/A
UHF Range 2	450–520 MHz	10–45 W variable	1–45 W variable	1–25 W variable
700–800 MHz	764–870 MHz	10–35 W variable (2–3 W itinerant)	2–35 W variable (2–3 W itinerant)	2–25 W variable (2–3 W itinerant)
900 MHz[1]	896–941 MHz (PCS band: 901–902 MHz 940–941 MHz)	N/A	1–30 W variable (3 W PCS band)	N/A

NOTE: APX 4500Li follows the minimum power variable of APX 4500.

The APX mobile radios are among the most sophisticated two-way radios available. They have a new robust design for radio users who need high performance, quality, and reliability in their daily communications. This new architecture supports a multitude of legacy and advanced features resulting in a more cost-effective two-way radio communications solution.

The tables below provide description of basic features for the APX mobile radios control head.

[1] APX 1500 does not support 900 MHz

Table 2: O2 Control Head Basic Features

Feature	APX 5500/APX 6500/APX 7500/APX 6500Li/APX 2500/APX 4500/APX 4500Li/APX 1500
Display	1 indicator line and 4 text lines (inclusive of menu)/14 characters of text, 320 x 144 RGB resolutions TFT Liquid-Crystal Display (LCD)
Control Type	Multifunction knob for Volume and Channel, Push Button On/Off, Home Keypad button, Data keypad button, Dimming button, Navigation Key
Numeric Keypad	Available with Keypad Microphone
Channel Capability	Maximum channel for APX 7500/APX 5500/APX 6500/APX 6500Li is 3000. Maximum channel for APX 4500/APX 4500Li/APX 2500 is 1000 Maximum channel for APX 1500 is 512
Remote Mount	Available
Dash Mount	Available
Dual Control Head	Available, but Dual Control Heads are not offered for APX 1500/APX 2500/APX 4500/APX 4500Li/APX 6500 Li
Motorcycle Configuration	Available, but APX 4500/APX 4500Li/APX 1500 do not support motorcycle configuration

IMPORTANT: For APX 4500 (900 MHz) radio, use O2 Control Head Kit P/N: PMHN4193_ and PMHN4195_ revision D onwards

Table 3: O3 Control Head Basic Features

Feature	APX 5500/APX 6500/APX 7500/APX 2500
Display	4 lines being for Primary, Secondary, Tertiary and Menu line. Max primary text area character size (WxH):12 x 18 pixels. Max secondary and tertiary text are character size (WxH):10 x 15 pixels. Color LCD with 3 dimming levels; High, Low and Off
Control Type	Push Button On/Off, Keypad Up/Down for Mode and Volume, Home Keypad Button, WAP keypad Button, 3 Menu Keypad Buttons, and 4 way navigation pad.
Numeric Keypad	12 Keypad consisting of 1–9, 0, * and #
Channel Capability	Maximum channel for all radios is 3000, except for APX 2500 is 1000
Remote Mount	Available
Dash Mount	Available
Dual Control Head	Not available
Motorcycle Configuration	Not available

NOTE: APX 4500/APX 4500Li/APX 1500 do not support O3 control head.

Table 4: O5 Control Head Basic Features

Feature	APX 5500/APX 6500/APX 7500/APX 6500Li
Display	2 lines/14 character of text, 1 menu line, bit map Liquid-Crystal Display (LCD)
Control Type	Rotary Mode and Volume Control, Push Button On/Off
Numeric Keypad	Available with Keypad Microphone
Channel Capability	3000
Remote Mount	Available
Dash Mount	Available
Dual Control Head	Available
Motorcycle Configuration	Available

NOTE: APX 4500Li/APX 1500 do not support O5 control head.

Table 5: E5 Control Head Basic Features

Feature	APX 5500/APX 6500/APX 7500/APX 6500Li
Display	3 lines/14 character of text, 1 menu line, 3.3” TFT Display, 480x160 Resolution RGB, IPS
Control Type	Rotary Mode and Volume Control, Push Button On/Off, Dim Button, Emergency Button, 4-Way Navigation Button, P Button, Home Button
Numeric Keypad	Available with Keypad Microphone
Channel Capability	3000
Remote Mount	Available
Dash Mount	Available
Dual Control Head	Available
Motorcycle Configuration	Available

NOTE: APX 4500Li/APX 1500 do not support E5 control head.

Table 6: O7 Control Head Basic Features

Feature	APX 5500/APX 6500/APX 7500/APX 6500Li/APX 2500
Display	1 indicator line and 4 text lines (inclusive of menu) / 14 characters of text, 320 x 144 RGD resolutions TFT Liquid-Crystal Display (LCD)
Control Type	Multifunction knob for Volume and Channel, Push Button On/Off, Home Keypad button, Data keypad button, Dimming button, Navigation Key
Numeric Keypad	Alpha numerical keypad consisting of 1–9, 0, * and #

Feature	APX 5500/APX 6500/APX 7500/APX 6500Li/APX 2500
Channel Capability	Maximum channel for all radios is 3000, except for APX 2500 is 1000
Remote Mount	Available
Dash Mount	Available
Dual Control Head	Available
Motorcycle Configuration	Available

NOTE: APX 4500/4500Li/1500 do not support O7 control head.

Table 7: O9 Control Head Basic Features

Feature	APX 7500
Display	4 lines/14 character of text, 480 X 272 RGB resolution TFT Liquid-Crystal Display (LCD)
Control Type	Rotary Mode and Volume Control, Push Button On/Off, Illumination rocker
Numeric Keypad	Alpha numerical keypad consisting of 1–9, 0, * and #
Channel Capability	3000
Remote Mount	Available
Dash Mount	Not Available
Dual Control Head	Not Available
Motorcycle Configuration	Not Available

NOTE: Only APX 7500 supports O9 control head.

1.2 FLASHport®

All APX mobile radios are part of the FLASHport program and ship standard with a FLASH IC, which allows for feature and system upgrades.

FLASHport Aftermarket Software is used to upgrade to the latest version of your System Enhancement Software Package, to upgrade to a different System Enhancement Software Package, or to order enhancements for existing APX mobile radios in the field.

1.3 Control Head Descriptions

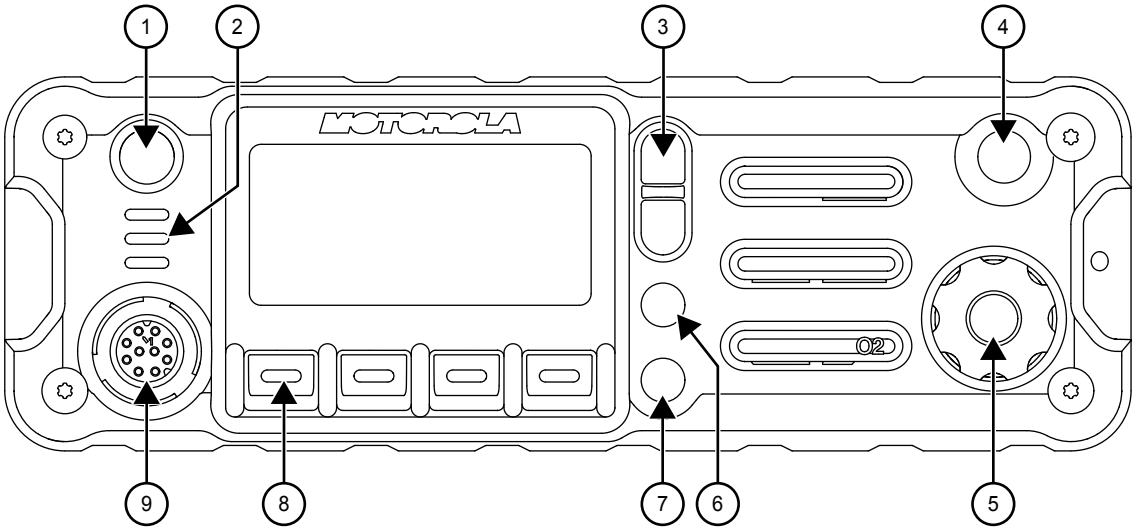
The control head used with APX mobile radios has microprocessor circuitry that operates the standard and optional features built into the system.

The following illustrations show a typical APX mobile radio control head.

1.3.1

O2 Control Head

Figure 1: O2 Control Head

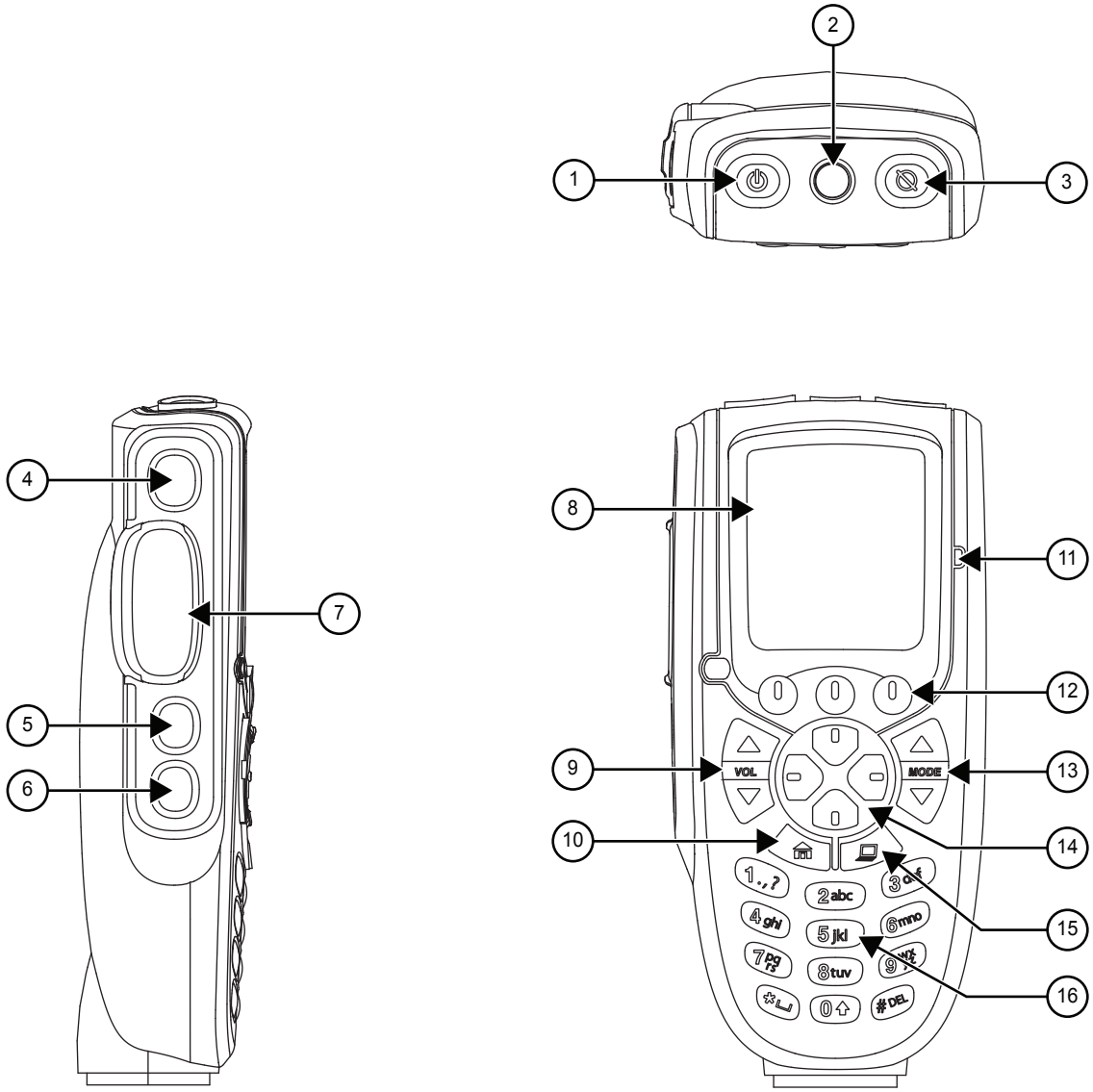


1	POWER ON/OFF BUTTON – Turns the radio on and off.
2	LED STATUS INDICATORS – Red, Yellow, and Green LEDs that indicate transmits, busy, and private call respectively.
3	UP/DOWN BUTTONS – Used to scroll through menu items and selections.
4	EMERGENCY BUTTON – A button that can be custom programmed by system manager and usually used for the emergency feature.
5	MULTI-FUNCTION KNOB – Used to change audio volume and channels.
6	DIM BUTTON – Use this button to adjust the brightness of the display. Long press to toggle between day and night mode.
7	HOME BUTTON – Used to exit all menu functions. The long press behavior of the HOME button is programmable.
8	MENU SELECT BUTTONS – Field-programmable buttons.
9	ACCESSORY PORT – (MICROPHONE)

1.3.2

O3 Control Head

Figure 2: O3 Control Head

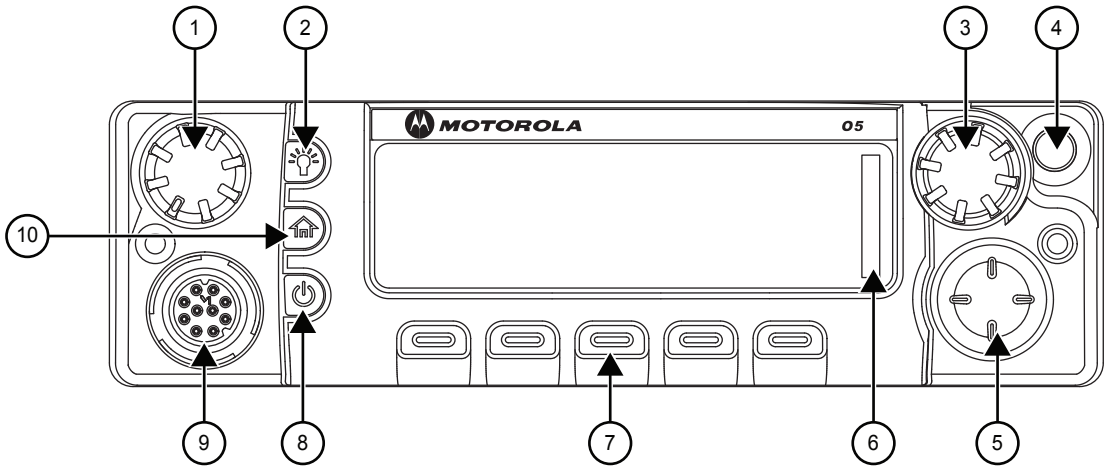


1	POWER ON/OFF BUTTON – Turns the radio on and off.
2	ORANGE BUTTON – Programmed at the factory to activate the Emergency feature.
3	TOP PROGRAMMABLE BUTTON – Buttons that can be custom programmed by system manager.
4	PROGRAMMABLE BUTTON (Monitor) – Buttons that can be custom programmed by system manager.
5	SIDE PROGRAMMABLE BUTTONS 1– Buttons that can be custom programmed by system manager.
6	SIDE PROGRAMMABLE BUTTONS 2 – Buttons that can be custom programmed by system manager.

7	PUSH TO TALK BUTTON – Pressed to transmit on the displayed mode and released to receive.
8	14-CHARACTER DISPLAY
9	VOLUME ROCKER – Adjust the volume level up or down.
10	HOME BUTTON – Used to exit all menu functions.
11	LED INDICATOR – Green/red light-emitting diode that indicates radio status as you operate various features.
12	PROGRAMMABLE SOFTKEYS – Field-programmable buttons
13	MODE ROCKER – Scroll up or down through the list of available modes.
14	NAVIGATION KEYS – Used to scroll through menu items and selections.
15	DATA BUTTON
16	NUMERIC KEYPAD – Features 12 keys and used to enter menus, scroll through a list of displayed options, and enter data.

1.3.3
O5 Control Head

Figure 3: O5 Control Head

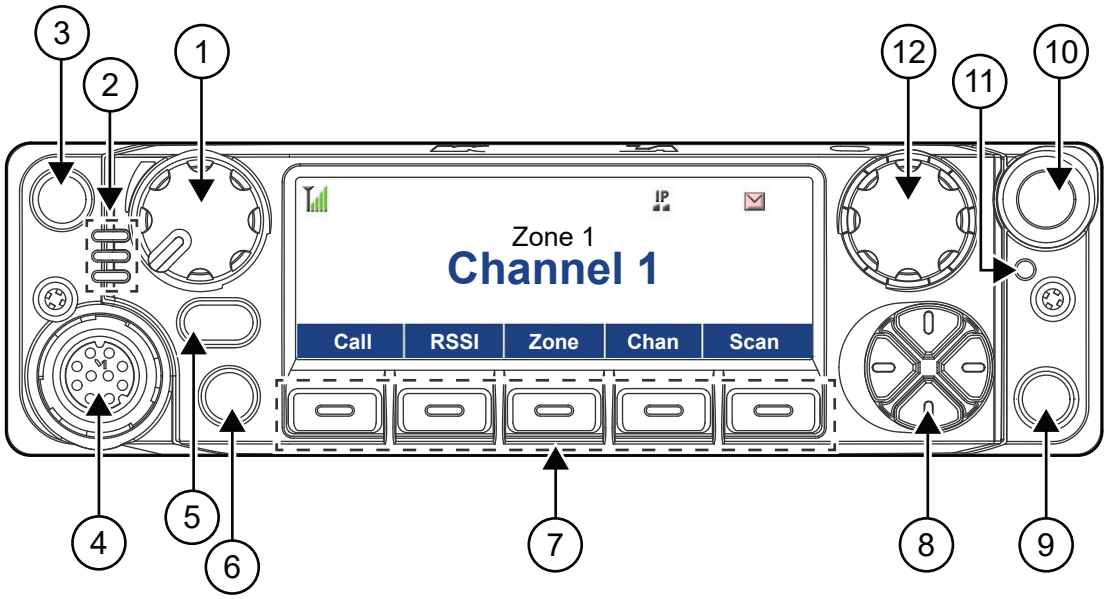


1	VOLUME KNOB – Changes the audio volume.
2	DIM BUTTON – Dims the backlight through three levels of brightness including backlight off.
3	MODE KNOB – Used to change channels.
4	EMERGENCY – Field-programmable button via CPS, typically programmed for the emergency feature but other functions are possible.
5	NAVIGATION KEY – Used to scroll through menu items and selections.
6	INDICATORS – Red, Yellow and Green LED's that indicate transmit, busy and private call respectively.
7	SOFT MENU KEYS – Field-programmable buttons.
8	POWER ON/OFF – Turns the radio on and off.

9	MMP CONNECTOR – Used to connect accessories, such as the microphone, to the control head.
10	HOME – Used to exit all menu functions. The long press behavior of the HOME button is programmable.

1.3.4
E5 Control Head

Figure 4: E5 Control Head

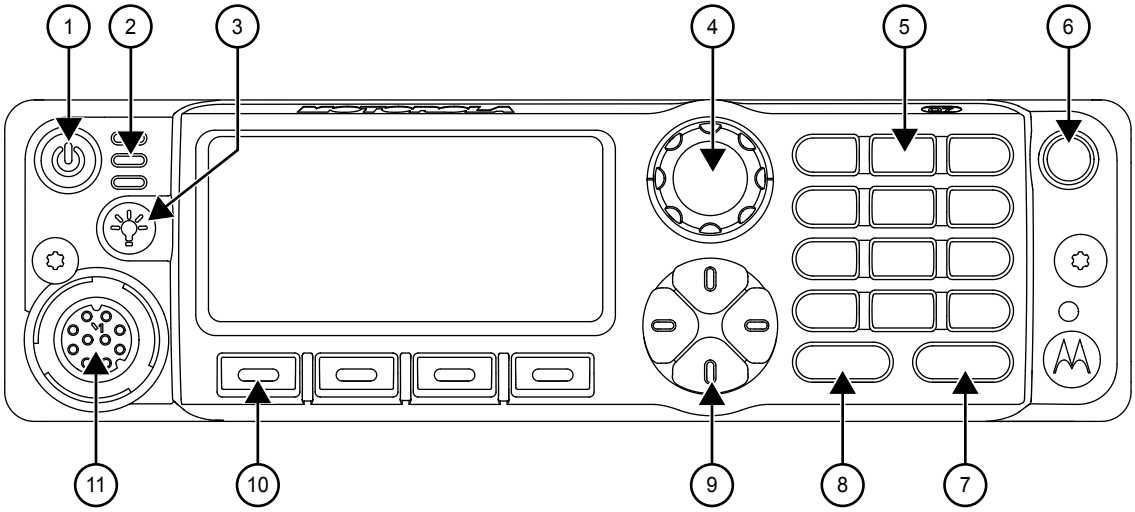


1	VOLUME KNOB – Changes the audio volume.
2	LED STATUS INDICATORS – Red, Yellow, and Green LEDs that indicates transmit, busy, and private call respectively.
3	POWER ON/OFF – Turns the radio on and off.
4	MMP CONNECTOR – Used to connect accessories, such as the microphone, to the control head.
5	DIMMER BUTTON – Dims the backlight through eight levels of brightness including backlight off. Long press to toggle between day and night mode.
6	P BUTTON - Field-programmable buttons.
7	MENU SELECT BUTTONS – Field-programmable buttons.
8	4-WAY NAVIGATION BUTTON – Used to scroll through menu items and selections.
9	HOME BUTTON – Used to exit all menu functions. The long press behavior of the HOME button is programmable.
10	EMERGENCY BUTTON – Field-programmable button via CPS, typically programmed for the emergency feature but other functions are possible.
11	Bluetooth Pairing Location Indicator
12	MODE KNOB – Used to change channels.

1.3.5

O7 Control Head

Figure 5: O7 Control Head



1	POWER ON/OFF BUTTON – Turns the radio on and off.
2	LED STATUS INDICATORS – Red, Yellow, and Green LEDs that indicates transmit, busy, and private call respectively.
3	DIM BUTTON – Use this button to adjust the brightness of the display. Long press to toggle between day and night mode.
4	MULTI-FUNCTION KNOB – Used to change audio volume and channels.
5	DTMF BUTTON – The Dual Tone Multi-Frequency (DTMF) Signaling Button is used to perform Siren and Light functions.
6	EMERGENCY BUTTON – A button that can be custom programmed by system manager and usually used for the emergency feature.
7	DATA BUTTON – Used to access data-related features, such as the Text Messaging Service (TMS) feature screen.
8	HOME BUTTON – Used to exit all menu functions. The long press behavior of the HOME button is programmable.
9	4-WAY NAVIGATION BUTTON – Used to scroll through menu items and selections.
10	MENU SELECT BUTTONS – Field-programmable buttons.
11	ACCESSORY PORT – (MICROPHONE)

1.3.6

O9 Control Head

Figure 6: O9 Control Head

1	SIREN CONTROL BUTTONS
2	RESPONSE SELECTOR
3	DIRECTIONAL BUTTONS
4	ORANGE BUTTON– Field-programmable button usually used for the emergency feature
5	PUBLIC ADDRESS BUTTON
6	KEYPAD
7	4-WAY NAVIGATION BUTTON – Used to scroll through menu items and selections.
8	DATA FEATURE BUTTON
9	MODE KNOB – Used to change channels.

10	HOME BUTTON – Used to exit all menu functions. The long press behavior of the HOME button is programmable.
11	PROGRAMMABLE BUTTON – Buttons that can be custom programmed by system manager.
12	VOLUME KNOB – Changes the audio volume.
13	MENU SELECT BUTTONS – Field-programmable buttons.
14	DISPLAY BACKLIGHT CONTROL BUTTONS
15	STATUS ICONS
16	LED INDICATORS – Red, Yellow, and Green LED's that indicate transmit, busy and private call respectively.
17	POWER ON/OFF BUTTON – Turns the radio on and off.
18	TOP PROGRAMMABLE BUTTON – Buttons that can be custom programmed by system manager.

1.4 P25 Digital Vehicular Repeater System

P25 Digital Vehicular Repeater System (DVRS) is a Motorola Solutions MSI Certified APX compatible third-party system.

The P25 DVRS provides portable radio coverage in the following area:

- Only where mobile radio coverage is available.
- Portable radio coverage is either intermittent or unavailable.

1.5 APX Mobile Radios Model Numbering, Charts, and Specifications

Table 8: Sales Model Nomenclature

Position	1	2	3	4	5	6	7	8	9	10	11	12
Typical Model Number	M	3	0	U	R	S	9	P	W	1	A	N

Table 9: Sales Models–Description of Symbols

Position	Description	Value
1	Type of Unit	M = Mobile L = Table Top Station
2	Model Series	36 = APX 1500
3		24 = APX 2500
		22 = APX 4500/4500Li
		25 = APX 6500/5500/6500Li
		30 = APX 7500

Position	Description	Value
4	Frequency Band	K = 136 MHz to 174 MHz
		Q = 380 MHz to 470 MHz
		S = 450 MHz to 520 MHZ
		U = 764 MHz to 870 MHz
		Values given represent range only; they are not absolute.
5	Power Level	R = 10 W to 35 W
		S = 10 W to 50 W
		T = 25 W to 110 W
6	Physical Packages	S = Tranceiver with Selectable Control Head
7	Channel Spacing	9 = Variable/Programmable
8	Primary Operation	P = Programmable
9	Primary System Type	W = Programmable
10	Feature Level	1 = Basic
11	Version	Model Version–for example A, B C (Major Change)
12	Unique Model Variations	N = Standard Package

1.5.1
VHF Radio Specifications

NOTE:
Specifications subject to change without notice.

* Measured in analog mode per TIA/EIA 603 under nominal conditions.

** Measured in digital mode per TIA/EIA IS 102.CAAB.

Table 10: General (VHF)

Parameters	Value
FCC Designations	AZ492FT7047
	AZ492FT3821
	AZ492FT4898
	AZ492FT4895
	AZ492FT7037
	AZ492FT7035
	AZ492FT3824
	AZ492FT3826
Temperature Range	Operating: -30°C to +60°C
	Storage: -55°C to +85°C
Power Supply	12 Vdc Negative Ground Only

Parameters	Value
Battery Drain: (Maximum) for 50 W radios	Standby @ 13.8 V: 0.85 A
	Receive at Rated Audio @ 13.8 V: 3.2 A
	Transmit @ Rated Power: 15 W 8.0 A/50 W 13.0 A
Battery Drain: (Maximum) for 100 W radios	Standby @ 13.8 V: 0.85 A
	Receive at Rated Audio @ 13.8 V: 3.2 A
	Transmit @ Rated Power: 100 W 20.0 A
Dimensions (H x W x D) *	
APX 5500/6500/7500 Mid Power Radio Transceiver	50.8 mm x 177.8 mm x 218.4 mm
	(2" x 7" x 8.6")
O5 Control Head	50.8 mm x 180.3 mm x 63.5 mm
	(2" x 7" x 2.5")
O2 Control Head	68.4 mm x 206 mm x 52.83 mm
	(2.7" x 8" x 2.1")
O7 Control Head	50.8 mm x 178 mm x 40 mm
	(2" x 7" x 1.5")
E5 Control Head	51.3 mm x 178.5 mm x 63.8 mm
	(2.0" x 7.0" x 2.5")
APX 5500/6500/7500 Mid Power Radio Transceiver and O5 Control Head – Dash Mount	50.8 mm x 180.3 mm x 243.8 mm
	(2" x 7" x 9.6")
APX 5500/65007500 Mid Power Radio Transceiver and O2 Control Head – Dash Mount	68.4 mm x 206 mm x 268 mm
	(2.7" x 8" x 10.5")
APX 5500/6500/7500 Mid Power Radio Transceiver and O7 Control Head – Dash Mount	50.8 mm x 178 mm x 262 mm
	(2" x 7" x 10.3")
APX 5500/6500/7500 Mid Power Radio Transceiver and E5 Control Head – Dash Mount	51.3 mm x 178.5 mm x 246 mm
	(2" x 7" x 9.6")
APX 5500/6500/7500 Mid Power Radio Transceiver and Remote Mount	50.8 mm x 180.3 mm x 243.8 mm
	2" x 7 "x 9.6")
APX 5500/6500/7500 High Power Radio Transceiver	74 (87 locally at handle) mm x 293 mm x 223 mm
	(2.9" (3.4" locally at handle) x 11.5" x 8.8")
APX 2500/4500/4500Li/1500 Mid Power Radio Transceiver	50.8 mm x 178 mm x 163mm
	(2" x 7" x 6.4")
O2 Control Head	68.4 mm x 206 mm x 52.83 mm
	(2.7" x 8" x 2.1")
O5 Control Head	51 mm x 180 mm x 40.5 mm
	(2" x 7" x 1.6")

Parameters	Value
O7 Control Head	50.8 mm x 178 mm x 40 mm
	(2" x 7" x 1.5")
E5 Control Head	51.3 mm x 178.5 mm x 45.4 mm
	(2.0" x 7.0" x 1.7")
APX 2500/4500/4500Li/1500 Mid Power Radio Transceiver and O2 Control Head – Dash Mount	68.4 mm x 206 mm x 223 mm
	(2.7" x 8" x 8.8")
APX 2500/4500 Mid Power Radio Transceiver and O5 Control Head – Dash Mount	51 mm x 180 mm x 200 mm
	(2" x 7" x 7.9")
APX 2500 Mid Power Radio Transceiver and O7 Control Head – Dash Mount	50.8 mm x 178 mm x 208 mm
	(2" x 7" x 8.2")
APX 2500/4500 Mid Power Radio Transceiver and E5 Control Head – Dash Mount	51.3 mm x 178.5 mm x 209 mm
	(2.0" x 7.0" x 8.2")
APX 2500/4500 Mid Power Radio Transceiver and Remote Mount	50.8 mm x 180.3 mm x 194mm
	(2" x 7 " x 7.6")
Weight	
APX 5500/6500/7500 Mid Power Radio Transceiver and Control Head	3.17 kg (7 lbs)
APX 5500/6500/7500 High Power Radio Transceiver	6.4 kg (14.2 lbs with trunnion)
	5.4 kg (12 lbs without trunnion)
APX 2500/4500/4500Li/1500 Mid Power Radio Transceiver and O2 Control Head	2.45 kg (5.28 lbs)
APX 2500/4500 Mid Power Radio Transceiver and O5 Control Head	2.24 kg (4.94 lbs)
APX 2500 Mid Power Radio Transceiver and O7 Control Head	2.24 kg (4.94 lbs)
APX 2500/4500 Mid Power Radio Transceiver and E5 Control Head	2.24 kg (4.94 lbs)
APX 2500/4500 Mid Power Radio Transceiver and Remote Mount	2.18 kg (4.70 lbs)
NOTE: All dimensions and weights are stated by excluding any mounting hardware or cables.	

Table 11: Receiver (VHF)

Parameters	Value
Frequency Range:	136–174 MHz
Channel Spacing:	12.5 kHz/25 kHz/30 kHz
Input Impedance:	50 Ω
Frequency Separation:	Full Band Split

Parameters	Value
Sensitivity* (With preamplifier)	
20 dB Quieting: (25 kHz Channel Spacing)	0.25 µV
12 dB SINAD: (25 kHz Channel Spacing)	0.16 µV
Sensitivity* (Without preamplifier)	
20 dB Quieting: (25 kHz Channel Spacing)	0.4 µV
12 dB SINAD: (25 kHz Channel Spacing)	0.25 µV
Intermodulation*	
With preamplifier (Measured in the Analog Mode)	82 dB
Without preamplifier (Measured in the Analog Mode)	87 dB
Digital Sensitivity** with preamplifier	
1% BER (12.5 kHz channel)	0.25 µV
5% BER (12.5 kHz channel)	0.16 µV
Digital Sensitivity** without preamplifier	
1% BER (12.5 kHz channel)	0.4 µV
5% BER (12.5 kHz channel)	0.25 µV
Selectivity*	
30 kHz Channel Spacing	90 dB
12.5 kHz Channel Spacing	77 dB
Spurious Rejection*	95 dB
Frequency Stability	
–30° to +60°C; 25°C Reference	±0.8 ppm
Audio Output*	
Measured in the Analog Mode at less than 3% distortion. Maximum output level of Speaker lines are 33 W with 3.2 Ω speaker. Acceptable speaker loads are between 3 Ω to 10 Ω total. Attenuate headphones as needed for impedance and power rating.	7.5 W (8 Ω Speaker) 15 W (3.2 Ω Speaker)

Table 12: Transmitter (VHF)

TRANSMITTER	Value
Frequency Range	136–174 MHz
Rated Output Power	
Motorcycle Radio	15 W
Low-Power Radio	25 W
Mid-Power Radio	50 W
High-Power Radio	100 W

TRANSMITTER	Value
Channel Spacing	12.5 kHz, 25 kHz, or 30 kHz
Output Impedance	50 Ω
Frequency Separation	Full Band Split
Frequency Stability	(-30° to +60°C; 25°C Ref.): ±0.8 ppm
Modulation Limiting	
25 kHz Channel Spacing	±5.0 kHz
12.5 kHz Channel Spacing	±2.5 kHz
Frequency Deviation for (C4FM)	12.5 kHz Digital Channel: ±2.8 kHz
FM Hum and Noise	25 kHz Channel Spacing: -52 dB
	12.5 kHz Channel Spacing: -51 dB
Emission (Conduct/Radiated)	-85 dBc/-20dBm
Audio Sensitivity	
For 60% Max. Deviation at 1 kHz	0.08V ±3 dB
Audio Response (Measured in the Analog Mode)	
6 dB/Octave Pre-Emphasis 300 to 3000 Hz	+1, -3 dB
Audio Distortion (For 60% Max. Deviation at 1 kHz)	0.50% per EIA
Emissions Designators	8K10F1D, 8K10F1E, 8K10F1W, 11K0F3E, 16K0F3E, 20K0F1E

1.5.2
UHF R1 Radio Specifications

NOTE:
Specifications subject to change without notice.

* Measured in analog mode per TIA/EIA 603 under nominal conditions.

** Measured in digital mode per TIA/EIA IS 102.CAAB.

Table 13: General (UHF R1)

Parameters	Value
FCC Designations	AZ492FT4894 AZ492FT4897 AZ492FT4898 AZ492FT4895 AZ492FT7043 AZ492FT7048 AZ492FT4904 AZ492FT4915
Temperature Range	Operating: -30°C to +60°C
	Storage: -55°C to +85°C

Parameters	Value
Power Supply	12 Vdc Negative Ground Only
Battery Drain: (Maximum) for 40 W radios	Standby @ 13.8 V: 0.85 A
	Receive at Rated Audio @ 13.8 V: 3.2 A
	Transmit @ Rated Power: 15 W 8.0 A/40 W 13.0 A
Battery Drain: (Maximum) for 100 W radios	Standby @ 13.8 V: 0.85 A
	Receive at Rated Audio @ 13.8 V: 3.2 A
	Transmit @ Rated Power: 100 W 24.0 A
Dimensions (H x W x D)*	
APX 5500/6500/7500 Mid Power Radio Transceiver	50.8 mm x 177.8 mm x 218.4 mm
	(2" x 7" x 8.6")
O5 Control Head	50.8 mm x 180.3 mm x 63.5 mm
	(2" x 7" x 2.5")
O2 Control Head	68.4 mm x 206 mm x 52.83 mm
	(2.7" x 8" x 2.1")
O7 Control Head	50.8 mm x 178 mm x 40 mm
	(2" x 7" x 1.5")
E5 Control Head	51.3 mm x 178.5 mm x 63.8 mm
	(2.0" x 7.0" x 2.5")
APX 5500/6500/7500 Mid Power Radio Transceiver and O5 Control Head – Dash Mount	50.8 mm x 180.3 mm x 243.8 mm
	(2" x 7" x 9.6")
APX 5500/65007500 Mid Power Radio Transceiver and O2 Control Head – Dash Mount	68.4 mm x 206 mm x 268 mm
	(2.7" x 8" x 10.5")
APX 5500/6500/7500 Mid Power Radio Transceiver and O7 Control Head – Dash Mount	50.8 mm x 178 mm x 262 mm
	(2" x 7" x 10.3")
APX 5500/6500/7500 Mid Power Radio Transceiver and E5 Control Head – Dash Mount	51.3 mm x 178.5 mm x 246 mm
	(2" x 7" x 9.6")
APX 5500/6500/7500 Mid Power Radio Transceiver and Remote Mount	50.8 mm x 180.3 mm x 243.8 mm
	(2" x 7 "x 9.6")
APX 5500/6500/7500 High Power Radio Transceiver	74 (87 locally at handle) mm x 293 mm x 223 mm
	(2.9" (3.4" locally at handle) x 11.5" x 8.8")
APX 2500/4500/4500Li/1500 Mid Power Radio Transceiver	50.8 mm x 178 mm x 163mm
	(2" x 7" x 6.4")
O2 Control Head	68.4 mm x 206 mm x 52.83 mm
	(2.7" x 8" x 2.1")
O5 Control Head	51 mm x 180 mm x 40.5 mm

Parameters	Value
	(2" x 7" x 1.6")
O7 Control Head	50.8 mm x 178 mm x 40 mm
	(2" x 7" x 1.5")
E5 Control Head	51.3 mm x 178.5 mm x 45.4 mm
	(2.0" x 7.0" x 1.7")
APX 2500/4500/4500Li/1500 Mid Power Radio Transceiver and O2 Control Head – Dash Mount	68.4 mm x 206 mm x 223 mm
	(2.7" x 8" x 8.8")
APX 2500/4500 Mid Power Radio Transceiver and O5 Control Head – Dash Mount	51 mm x 180 mm x 200 mm
	(2" x 7" x 7.9")
APX 2500 Mid Power Radio Transceiver and O7 Control Head – Dash Mount	50.8 mm x 178 mm x 208 mm
	(2" x 7" x 8.2")
APX 2500/4500 Mid Power Radio Transceiver and E5 Control Head – Dash Mount	51.3 mm x 178.5 mm x 209 mm
	(2.0" x 7.0" x 8.2")
APX 2500/4500 Mid Power Radio Transceiver and Remote Mount	50.8 mm x 180.3 mm x 194mm
	(2" x 7 " x 7.6")
Weight	
APX 5500/6500/7500 Mid Power Radio Transceiver and Control Head	3.17 kg (7 lbs)
APX 5500/6500/7500 High Power Radio Transceiver	6.4 kg (14.2 lbs with trunnion)
	5.4 kg (12 lbs without trunnion)
APX 2500/4500/4500Li/1500 Mid Power Radio Transceiver and O2 Control Head	2.45 kg (5.28 lbs)
APX 2500/4500 Mid Power Radio Transceiver and O5 Control Head	2.24 kg (4.94 lbs)
APX 2500 Mid Power Radio Transceiver and O7 Control Head	2.24 kg (4.94 lbs)
APX 2500/4500 Mid Power Radio Transceiver and E5 Control Head	2.24 kg (4.94 lbs)
APX 2500/4500 Mid Power Radio Transceiver and Remote Mount	2.18 kg (4.70 lbs)
NOTE: All dimensions and weights are stated by excluding ay mounting hardware or cables.	

Table 14: Receiver (UHF R1)

Parameters	Value
Frequency Range:	380–470 MHz
Channel Spacing:	12.5 kHz/25 kHz
Input Impedance:	50 Ω

Parameters	Value
Frequency Separation:	Full Bandsplit
Sensitivity* (With pre-amplifier)	
20 dB Quieting: (25 kHz Channel Spacing)	0.25 µV
12 dB SINAD: (25 kHz Channel Spacing)	0.16 µV
Sensitivity* (Without pre-amplifier)	
20 dB Quieting: (25 kHz Channel Spacing)	0.4 µV
12 dB SINAD: (25 kHz Channel Spacing)	0.25 µV
Intermodulation*	
With pre-amplifier (Measured in the Analog Mode)	81 dB
Without pre-amplifier (Measured in the Analog Mode)	86 dB
Digital Sensitivity** with pre-amplifier	
1% BER (12.5 kHz channel)	0.25 µV
5% BER (12.5 kHz channel)	0.16 µV
Digital Sensitivity** without pre-amplifier	
1% BER (12.5 kHz channel)	0.4 µV
5% BER (12.5 kHz channel)	0.25 µV
Selectivity*	
25 kHz Channel Spacing	83 dB
12.5 kHz Channel Spacing	72 dB
Spurious Rejection*	91 dB
Frequency Stability	
–30° to +60°C; 25°C Reference	±0.8 ppm
Audio Output*	
Measured in the Analog Mode at less than 3% distortion. Maximum output level of Speaker lines are 33 W with 3.2 Ω speaker. Acceptable speaker loads are between 3 Ω to 10 Ω total. Attenuate headphones as needed for impedance and power rating.	7.5 W (8 Ω Speaker)
	15 W (3.2 Ω Speaker)

Table 15: Transmitter (UHF R1)

TRANSMITTER	Value
Frequency Range	380–470 MHz
Rated Output Power	
Motorcycle Radio	15 W
Low-Power Radio	25 W
Mid-Power Radio	40 W

TRANSMITTER	Value
High-Power Radio	100 W
Channel Spacing	12.5 kHz or 25 kHz
Output Impedance	50 Ω
Frequency Separation	Full Bandsplit
Frequency Stability	(-30° to +60°C; 25°C Ref.): ±0.8 ppm
Modulation Limiting	
25 kHz Channel Spacing	±5.0 kHz
12.5 kHz Channel Spacing	±2.5 kHz
Frequency Deviation for (C4FM)	12.5 kHz Digital Channel: ±2.8 kHz
FM Hum and Noise	25 kHz Channel Spacing: -51 dB
	12.5 kHz Channel Spacing: -48 dB
Emission (Conduct/Radiated)	-85 dBc/-20dBm
Audio Sensitivity	
For 60% Max. Deviation at 1 kHz	0.08V ±3 dB
Audio Response (Measured in the Analog Mode)	
6 dB/Octave Pre-Emphasis 300 to 3000 Hz	+1, -3 dB
Audio Distortion (For 60% Max. Deviation at 1 kHz)	0.50% per EIA
Emissions Designators	8K10F1D, 8K10F1E, 8K10F1W, 11K0F3E, 16K0F3E, 20K0F1E

1.5.3
UHF R2 Radio Specifications

NOTE:
Specifications subject to change without notice.

*Does not support 25 KHz channel spacing (16K0F3E, 20K0F1E) in North America.

Table 16: General (UHF R2)

Parameters	Value
FCC Designations	AZ492FT4896
	AZ492FT7044
	AZ492FT7047
	AZ492FT4904
	AZ492FT4916
Temperature Range	Operating: -30°C to +60°C
	Storage: -55°C to +85°C
Power Supply	12 Vdc Negative Ground Only
Battery Drain: (Maximum) for 45 W radios	Standby @ 13.8 V: 0.85 A

Parameters	Value
	Receive at Rated Audio @ 13.8 V: 3.2 A
	Transmit @ Rated Power: 15 W 8.0 A/45 W 11.0 A
Dimensions (H x W x D)*	
APX 5500/6500/7500 Mid Power Radio Transceiver	50.8 mm x 177.8 mm x 218.4 mm
	(2" x 7" x 8.6")
O5 Control Head	50.8 mm x 180.3 mm x 63.5 mm
	(2" x 7" x 2.5")
O2 Control Head	68.4 mm x 206 mm x 52.83 mm
	(2.7" x 8" x 2.1")
O7 Control Head	50.8 mm x 178 mm x 40 mm
	(2" x 7" x 1.5")
E5 Control Head	51.3 mm x 178.5 mm x 63.8 mm
	(2.0" x 7.0" x 2.5")
APX 5500/6500/7500 Mid Power Radio Transceiver and O5 Control Head – Dash Mount	50.8 mm x 180.3 mm x 243.8 mm
	(2" x 7" x 9.6")
APX 5500/65007500 Mid Power Radio Transceiver and O2 Control Head – Dash Mount	68.4 mm x 206 mm x 268 mm
	(2.7" x 8" x 10.5")
APX 5500/6500/7500 Mid Power Radio Transceiver and O7 Control Head – Dash Mount	50.8 mm x 178 mm x 262 mm
	(2" x 7" x 10.3")
APX 5500/6500/7500 Mid Power Radio Transceiver and E5 Control Head – Dash Mount	51.3 mm x 178.5 mm x 246 mm
	(2" x 7" x 9.6")
APX 5500/6500/7500 Mid Power Radio Transceiver and Remote Mount	50.8 mm x 180.3 mm x 243.8 mm
	2" x 7 "x 9.6")
APX 2500/4500/4500Li/1500 Mid Power Radio Transceiver	50.8 mm x 178 mm x 163mm
	(2" x 7" x 6.4")
O2 Control Head	68.4 mm x 206 mm x 52.83 mm
	(2.7" x 8" x 2.1")
O5 Control Head	51 mm x 180 mm x 40.5 mm
	(2" x 7" x 1.6")
O7 Control Head	50.8 mm x 178 mm x 40 mm
	(2" x 7" x 1.5")
E5 Control Head	51.3 mm x 178.5 mm x 45.4 mm
	(2.0" x 7.0" x 1.7")
APX 2500/4500/4500Li/1500 Mid Power Radio Transceiver and O2 Control Head – Dash Mount	68.4 mm x 206 mm x 223 mm
	(2.7" x 8" x 8.8")

Parameters	Value
APX 2500/4500 Mid Power Radio Transceiver and O5 Control Head – Dash Mount	51 mm x 180 mm x 200 mm
	(2" x 7" x 7.9")
APX 2500 Mid Power Radio Transceiver and O7 Control Head – Dash Mount	50.8 mm x 178 mm x 208 mm
	(2" x 7" x 8.2")
APX 2500/4500 Mid Power Radio Transceiver and E5 Control Head – Dash Mount	51.3 mm x 178.5 mm x 209 mm
	(2.0" x 7.0" x 8.2")
APX 2500/4500 Mid Power Radio Transceiver and Remote Mount	50.8 mm x 180.3 mm x 194mm
	(2" x 7 " x 7.6")
Weight	
APX 5500/6500/7500 Mid Power Radio Transceiver and Control Head	3.17 kg (7 lbs)
APX 2500/4500/4500Li/1500 Mid Power Radio Transceiver and O2 Control Head	2.45 kg (5.28 lbs)
APX 2500/4500 Mid Power Radio Transceiver and O5 Control Head	2.24 kg (4.94 lbs)
APX 2500 Mid Power Radio Transceiver and O7 Control Head	2.24 kg (4.94
APX 2500/4500 Mid Power Radio Transceiver and E5 Control Head	2.24 kg (4.94 lbs)
APX 2500/4500 Mid Power Radio Transceiver and Remote Mount	2.18 kg (4.70 lbs)
NOTE: All dimensions and weights are stated by excluding ay mounting hardware or cables.	

Table 17: Receiver (UHF R2)

Parameters	Value
Frequency Range:	450–520 MHz
Channel Spacing:	12.5 kHz/25 kHz
Input Impedance:	50 Ω
Frequency Separation:	Full Bandsplit
Sensitivity* (With pre-amplifier)	
20 dB Quieting: (25 kHz Channel Spacing)	0.25 µV
12 dB SINAD: (25 kHz Channel Spacing)	0.16 µV
Sensitivity* (Without pre-amplifier)	
20 dB Quieting: (25 kHz Channel Spacing)	0.4 µV
12 dB SINAD: (25 kHz Channel Spacing)	0.25 µV
Intermodulation*	
With pre-amplifier (Measured in the Analog Mode)	81 dB

Parameters	Value
Without pre-amplifier (Measured in the Analog Mode)	86 dB
Digital Sensitivity** with pre-amplifier	
1% BER (12.5 kHz channel)	0.25 µV
5% BER (12.5 kHz channel)	0.16 µV
Digital Sensitivity** without pre-amplifier	
1% BER (12.5 kHz channel)	0.4 µV
5% BER (12.5 kHz channel)	0.25 µV
Selectivity*	
25 kHz Channel Spacing	83 dB
12.5 kHz Channel Spacing	72 dB
Spurious Rejection*	91 dB
Frequency Stability	
–30° to +60°C; 25°C Reference	±0.8 ppm
Audio Output*	
Measured in the Analog Mode at less than 3% distortion. Maximum output level of Speaker lines are 33 W with 3.2 Ω speaker. Acceptable speaker loads are between 3 Ω to 10 Ω total. Attenuate headphones as needed for impedance and power rating.	7.5 W (8 Ω Speaker)
	15 W (3.2 Ω Speaker)

Table 18: Transmitter (UHF R2)

TRANSMITTER	Value
Frequency Range	450–520 MHz
Rated Output Power	
Motorcycle Radio	15 W
Low-Power Radio	25 W
Mid-Power Radio	45 W
Channel Spacing	12.5 kHz or 25 kHz
Output Impedance	50 Ω
Frequency Separation	Full Bandsplit
Frequency Stability	(-30° to +60°C; 25°C Ref.): ±0.8 ppm
Modulation Limiting	
25 kHz Channel Spacing	±5.0 kHz
12.5 kHz Channel Spacing	±2.5 kHz
Frequency Deviation for (C4FM)	12.5 kHz Digital Channel: ±2.8 kHz
FM Hum and Noise	25 kHz Channel Spacing: -51 dB
	12.5 kHz Channel Spacing: -48 dB

TRANSMITTER	Value
Emission (Conduct/Radiated)	-85 dBc/-20dBm
Audio Sensitivity	
For 60% Max. Deviation at 1 kHz	0.08V ±3 dB
Audio Response (Measured in the Analog Mode)	
6 dB/Octave Pre-Emphasis 300 to 3000 Hz	+1, -3 dB
Audio Distortion (For 60% Max. Deviation at 1 kHz)	0.50% per EIA
Emissions Designators	8K10F1D, 8K10F1E, 8K10F1W, 11K0F3E, 16K0F3E, 20K0F1E

1.5.4

700–800 MHz Radio Specifications

NOTE:
Specifications subject to change without notice.

* Measured in analog mode per TIA/EIA 603 under nominal conditions.

** Measured in digital mode per TIA/EIA IS 102.CAAB.

*** 2–3 W. itinerant frequencies.

† Does not support 25 KHz spacing (16K0F3E, 20K0F1E) in North America.

Table 19: General (700–800 MHz)

Parameters	Value
FCC Designations	AZ492FT5858 AZ492FT7037 AZ492FT7035 AZ492FT7043 †AZ492FT7044 AZ492FT7048 AZ492FT7055
Temperature Range	Operating: -30°C to +60°C
	Storage: -40°C to +85°C
Power Supply	12 Vdc Negative Ground Only
Battery Drain: (Maximum) for 35 W radios	Standby @ 13.8 V: 0.85 A
	Receive at Rated Audio @ 13.8 V: 3.2 A
	Transmit @ Rated Power: 15 W 8.0 A/35 W 12.0 A
Dimensions (H x W x D)*	
APX 5500/6500/7500 Mid Power Radio Transceiver	50.8 mm x 177.8 mm x 218.4 mm
	(2" x 7" x 8.6")
O5 Control Head	50.8 mm x 180.3 mm x 63.5 mm

Parameters	Value
	(2" x 7" x 2.5")
O2 Control Head	68.4 mm x 206 mm x 52.83 mm
	(2.7" x 8" x 2.1")
O7 Control Head	50.8 mm x 178 mm x 40 mm
	(2" x 7" x 1.5")
E5 Control Head	51.3 mm x 178.5 mm x 63.8 mm
	(2.0" x 7.0" x 2.5")
APX 5500/6500/7500 Mid Power Radio Transceiver and O5 Control Head – Dash Mount	50.8 mm x 180.3 mm x 243.8 mm
	(2" x 7" x 9.6")
APX 5500/65007500 Mid Power Radio Transceiver and O2 Control Head – Dash Mount	68.4 mm x 206 mm x 268 mm
	(2.7" x 8" x 10.5")
APX 5500/6500/7500 Mid Power Radio Transceiver and O7 Control Head – Dash Mount	50.8 mm x 178 mm x 262 mm
	(2" x 7" x 10.3")
APX 5500/6500/7500 Mid Power Radio Transceiver and E5 Control Head – Dash Mount	51.3 mm x 178.5 mm x 246 mm
	(2" x 7" x 9.6")
APX 5500/6500/7500 Mid Power Radio Transceiver and Remote Mount	50.8 mm x 180.3 mm x 243.8 mm
	2" x 7 "x 9.6")
APX 5500/6500/7500 High Power Radio Transceiver	74 (87 locally at handle) mm x 293 mm x 223 mm
	(2.9" (3.4" locally at handle) x 11.5" x 8.8")
APX 2500/4500/4500Li/1500 Mid Power Radio Transceiver	50.8 mm x 178 mm x 163mm
	(2" x 7" x 6.4")
O2 Control Head	68.4 mm x 206 mm x 52.83 mm
	(2.7" x 8" x 2.1")
O5 Control Head	51 mm x 180 mm x 40.5 mm
	(2" x 7" x 1.6")
O7 Control Head	50.8 mm x 178 mm x 40 mm
	(2" x 7" x 1.5")
E5 Control Head	51.3 mm x 178.5 mm x 45.4 mm
	(2.0" x 7.0" x 1.7")
APX 2500/4500/4500Li/1500 Mid Power Radio Transceiver and O2 Control Head – Dash Mount	68.4 mm x 206 mm x 223 mm
	(2.7" x 8" x 8.8")
APX 2500/4500 Mid Power Radio Transceiver and O5 Control Head – Dash Mount	51 mm x 180 mm x 200 mm
	(2" x 7" x 7.9")
APX 2500 Mid Power Radio Transceiver and O7 Control Head – Dash Mount	50.8 mm x 178 mm x 208 mm
	(2" x 7" x 8.2")

Parameters	Value
APX 2500/4500 Mid Power Radio Transceiver and E5 Control Head – Dash Mount	51.3 mm x 178.5 mm x 209 mm
	(2.0" x 7.0" x 8.2")
APX 2500/4500 Mid Power Radio Transceiver and Remote Mount	50.8 mm x 180.3 mm x 194mm
	(2" x 7 " x 7.6")
Weight	
APX 5500/6500/7500 Mid Power Radio Transceiver and Control Head	3.17 kg (7 lbs)
APX 5500/6500/7500 High Power Radio Transceiver	6.4 kg (14.2 lbs with trunnion)
	5.4 kg (12 lbs without trunnion)
APX 2500/4500/4500Li/1500 Mid Power Radio Transceiver and O2 Control Head	2.45 kg (5.28 lbs)
APX 2500/4500 Mid Power Radio Transceiver and O5 Control Head	2.24 kg (4.94 lbs)
APX 2500 Mid Power Radio Transceiver and O7 Control Head	2.24 kg (4.94
APX 2500/4500 Mid Power Radio Transceiver and E5 Control Head	2.24 kg (4.94 lbs)
APX 2500/4500 Mid Power Radio Transceiver and Remote Mount	2.18 kg (4.70 lbs)
NOTE: All dimensions and weights are stated by excluding ay mounting hardware or cables.	

Table 20: Receiver (700–800 MHz)

Parameters	Value
Frequency Range:	700 MHz Band: 764–776 MHz
	800 MHz Band: 851–870 MHz
Channel Spacing:	12.5 kHz/20 kHz/25 kHz
Input Impedance:	50 Ω
Frequency Separation:	Full Bandsplit
Sensitivity	
20 dB Quieting: (25 kHz Channel Spacing)	0.30 µV
12 dB SINAD: (25 kHz Channel Spacing)	0.22 µV
Intermodulation*	82 dB
Digital Sensitivity**	
1% BER (12.5 kHz channel)	0.30 µV
5% BER (12.5 kHz channel)	0.20 µV
Adjacent Channel Selectivity*	
25 kHz Channel Spacing	85 dB

Parameters	Value
12.5 kHz Channel Spacing	75 dB
Spurious Rejection*	91 dB
Frequency Stability	
–30° to +60°C; 25°C Reference	±0.8 ppm
Audio Output at 3% Distortion*	
Measured in the Analog Mode at less than 3% distortion. Maximum output level of Speaker lines are 33 W with 3.2 Ω speaker. Acceptable speaker loads are between 3 Ω to 10 Ω total. Attenuate headphones as needed for impedance and power rating.	7.5 W (8 Ω Speaker)
	15 W (3.2 Ω Speaker)

Table 21: Transmitter (700–800 MHz)

TRANSMITTER	Value
Frequency Range	
700 MHz Band	Repeater Mode: 794–806 MHz
	Talkaround Mode: 764–776 MHz
800 MHz Band	Repeater Mode: 806–824 MHz
	Talkaround Mode: 851–870 MHz
Rated Output Power	
Motorcycle Radio (700/800 MHz Band)	2***/15 W
Vehicle Mount Radio	
700 MHz Band	2***/30 W
800 MHz Band	35 W
Channel Spacing	12.5 kHz/20 kHz/25 kHz
Output Impedance	50 Ω
Frequency Separation	Full Bandsplit
Frequency Stability	(-30° to +60°C; 25°C Ref.): ±0.8 ppm
Modulation Limiting*	
25 kHz Channel Spacing	±5.0 kHz
12.5 kHz Channel Spacing	±2.5 kHz
Frequency Deviation for (C4FM)**	12.5 kHz Digital Channel: ±2.8 kHz
FM Hum and Noise*	20/25 kHz Channel Spacing: -50 dB
	12.5 kHz Channel Spacing: -48 dB
Emission (Conduct/Radiated)	–70 dBc/–20dBm and –85 dBc/–40dBm (GNSS)
Audio Sensitivity	
For 60% Max. Deviation at 1 kHz	0.08 V ±3 dB
Audio Response*	

TRANSMITTER	Value
6 dB/Octave Pre-Emphasis 300 to 3000 Hz	+1, -3 dB
Audio Distortion*	0.50%
Emissions Designators	8K10F1D, 8K10F1E, 8K10F1W, 11K0F3E, 16K0F3E, 20K0F1E

1.5.5

900 MHz Radio Specifications

NOTE:
Specifications subject to change without notice.

* Measured in analog mode per TIA/EIA 603 under nominal conditions.

** Measured in digital mode per TIA/EIA IS 102.CAAB.

*** PCS band frequencies

† Does not support 25 KHz spacing (16K0F3E, 20K0F1E) in North America.

Table 22: General (900 MHz)

Parameters	Value
FCC Designations	AZ492FT5865
Temperature Range	Operating: -30°C to +60°C
	Storage: -40°C to +85°C
Power Supply	12 Vdc Negative Ground Only
Battery Drain: (Maximum) for 30 W radios	Standby @ 13.8 V: 0.85 A
	Receive at Rated Audio @ 13.8 V: 3.2 A
	Transmit @ Rated Power: 3.5 W 8.0 A/30 W 12.0 A
Dimensions (H x W x D)*	
APX 4500 Mid Power Radio Transceiver	50.8 mm x 178 mm x 163 mm
	(2" x 7" x 8.6")
O2 Control Head	68.4 mm x 206 mm x 52.83 mm
	(2.7" x 8" x 2.1")
O5 Control Head	51 mm x 180 mm x 40.5 mm
	(2" x 7" x 1.6")
E5 Control Head	51.3 mm x 178.5 mm x 45.4 mm
	(2.0" x 7.0" x 1.7")
APX 4500 Mid Power Radio Transceiver and O5 Control Head – Dash Mount	51 mm x 180 mm x 200 mm
	(2" x 7" x 7.9")
APX 4500 Mid Power Radio Transceiver and O2 Control Head – Dash Mount	68.4 mm x 206 mm x 223 mm
	(2.7" x 8" x 8.8")

Parameters	Value
APX 2500/4500 Mid Power Radio Transceiver and E5 Control Head – Dash Mount	51.3 mm x 178.5 mm x 209 mm
	(2.0" x 7.0" x 8.2")
Weight	
APX 4500 Mid Power Radio Transceiver and O2 Control Head	2.45 kg (5.28 lbs)
APX 4500 Mid Power Radio Transceiver and O5 Control Head	2.24 kg (4.94 lbs)
APX 2500/4500 Mid Power Radio Transceiver and E5 Control Head	2.24 kg (4.94 lbs)
NOTE: All dimensions and weights are stated by excluding ay mounting hardware or cables.	

Table 23: Receiver (900 MHz)

Parameters	Value
Frequency Range:	900 MHz Band: 935–941 MHz
Channel Spacing:	12.5 kHz
Input Impedance:	50 Ω
Frequency Separation:	Full Bandsplit
Sensitivity	
20 dB Quieting: (12.5 kHz Channel Spacing)	0.30 µV
12 dB SINAD: (12.5 kHz Channel Spacing)	0.22 µV
Intermodulation*	82 dB
Digital Sensitivity**	
1% BER (12.5 kHz channel)	0.30 µV
5% BER (12.5 kHz channel)	0.20 µV
Adjacent Channel Selectivity*	
12.5 kHz Channel Spacing	74 dB
Spurious Rejection*	91 dB
Frequency Stability	
–30° to +60°C; 25°C Reference	±0.8 ppm
Audio Output at 3% Distortion*	
Measured in the Analog Mode at less than 3% distortion. Maximum output level of Speaker lines are 33 W with 3.2 Ω speaker. Acceptable speaker loads are between 3 Ω to 10 Ω total. Attenuate headphones as needed for impedance and power rating.	7.5 W (8 Ω Speaker)
	15 W (3.2 Ω Speaker)

Table 24: Transmitter (900 MHz)

TRANSMITTER	Value
Frequency Range	
900 MHz Band	Repeater Mode: 896–902 MHz
	Talkaround Mode: 935–941 MHz
Rated Output Power	
896–902 MHz Band	1 W/ 30 W
935–941 MHz Band	1 W/30 W
***901–902 MHz Band:	3 W
***940–941 MHz Band	3 W
Channel Spacing	12.5 kHz
Output Impedance	50 Ω
Frequency Separation	Full Bandsplit
Frequency Stability	(-30° to +60°C; 25°C Ref.): ±0.8 ppm
Modulation Limiting*	
12.5 kHz Channel Spacing	±2.5 kHz
Frequency Deviation for (C4FM)**	12.5 kHz Digital Channel: ±2.8 kHz
FM Hum and Noise*	12.5 kHz Channel Spacing: -45 dB
Emission (Conduct/Radiated)	–70 dBc/–20dBm
Audio Sensitivity	
For 60% Max. Deviation at 1 kHz	0.08 V ±3 dB
Audio Response*	
6 dB/Octave Pre-Emphasis 300 to 3000 Hz	+1, -3 dB
Audio Distortion*	0.80%
Emissions Designators	8K10F1D, 8K10F1E, 8K10F1W, 11K0F3E

Chapter 2

Basic Maintenance

This chapter describes the preventive maintenance and handling precautions.

Each of these topics provides information vital to the successful operation and maintenance of the radio.

NOTE: For board and component level repair of the radio, refer to the *respective Detailed Service Manuals* (see Related Publications).

2.1 Preventive Maintenance

Radios are shipped from the factory with a worst-case frequency error.

For radios that have been in storage for over 6 months from the factory ship date, the reference oscillator should be checked when the radio is initially deployed to the field.

It is strongly recommended that the reference oscillator is checked every time the radio is serviced or at least once a year, whichever comes first.

The crystal contained in the reference oscillator naturally drifts over time due to its aging characteristic. Periodic adjustment of the reference oscillator is important for proper radio operation.

Improper adjustment can result in poor performance and interference with other users operating on adjacent channels.

See *Basic Service Manual* for reference oscillator alignment procedures.

The worst-case frequency errors are:

- ±250 Hz for VHF
- ±250 Hz for UHF
- ±600 Hz for 700–800 MHz
- ±600 Hz for 900 MHz

These specifications are tighter than the industry standards:

- ±2.0 ppm for the 136–174 MHz band
- ±2.0 ppm for the 380–470 MHz band Range 1/450–520 MHz band Range 2
- ±1.5 ppm for the 700–800 MHz bands
- ±1.0 ppm for the 900 MHz band

2.1.1 Inspection

Check that the external surfaces of the radio are clean and that all external controls and switches are functional. A detailed inspection of the interior electronic circuitry is not needed.

NOTE: Verify that all dust covers are in place.

2.1.2
Cleaning Procedures

The following procedures describe the recommended cleaning agents and the methods to be used when cleaning the external and internal surfaces of the radio.

External surfaces include the control head and radio chassis. These surfaces should be cleaned whenever a periodic visual inspection reveals the presence of smudges, grease, and/or grime. Internal surfaces should be cleaned only when the radio is disassembled for service or repair.

CAUTION:
Use all chemicals as prescribed by the manufacturer. Be sure to follow all safety precautions as defined on the label or material safety data sheet.

The effects of certain chemicals and their vapors can have harmful results on certain plastics. Aerosol sprays, tuner cleaners, circuit board cleaners, alcohols, and other chemicals should not make contact with plastic or metal radio housings.

The only recommended agent for cleaning the external radio surfaces is a 0.5% solution of a mild dishwashing detergent in water. The only factory recommended liquid for cleaning the printed circuit boards and their components is isopropyl alcohol (100% by volume).

Cleaning External Plastic Surfaces

Apply the 0.5% detergent-water solution sparingly with a stiff, non-metallic, short-bristled brush to work all loose dirt away from the radio. Use a soft, absorbent, lintless cloth or tissue to remove the solution and dry the radio. Make sure that no water remains entrapped near the connectors, cracks, or crevices.

Cleaning Internal Circuit Boards and Components

Isopropyl alcohol (100%) may be applied with a stiff, non-metallic, short-bristled brush to dislodge embedded or caked materials located in hard-to-reach areas. The brush stroke should direct the dislodged material out and away from the inside of the radio. Be careful not to break off electrical components.

Make sure that controls or tunable components are not soaked with alcohol. Do not use high-pressure air to hasten the drying process since this could cause the liquid to collect in unwanted places. After completing the cleaning process, use a soft, absorbent, lintless cloth to dry the area. Do not brush or apply any isopropyl alcohol to any plastic parts.

NOTE:
The cleaning can only be done after all the internal circuit boards and components are removed from the radio chassis.

Always use a fresh supply of alcohol and a clean container to prevent contamination by dissolved material (from previous usage).

2.1.3
General Radio Care and Handling Precautions

- Avoid physical abuse: do not pound, drop, or throw the radio. Exposed parts, such as controls and connectors, might be damaged.
- Operating the radio without an antenna cable attached may lead to radio failure and may void the warranty.
- Do not mount anything on the radio chassis fins, which are used for heat dissipation.

2.1.4
RF Power Amplifier (RF PA) Heatsinking

To avoid immediate failure of RF Power Amplifier (RF PA) or reduce the life of RF PA devices, install the following components in the chassis before transmitting:

- Printed-Circuit Board (PCB) DC
- RF connector clips
- Internal screws

If it is properly used, you can transmit for short period of time with the chassis eliminator.

2.2
Safe Handling of CMOS and LDMOS Devices

Complementary Metal Oxide Semiconductor (CMOS) and Laterally Diffused Metal Oxide Semiconductor (LDMOS) devices are used in this family of radios, and are susceptible to damage by electrostatic or high-voltage charges.

Damage can be latent, resulting in failures occurring weeks or months later. Therefore, special precautions must be taken to prevent device damage during disassembly, troubleshooting, and repair.

Handling precautions are mandatory for CMOS/LDMOS circuits and are especially important in low humidity conditions. Do not attempt to disassemble your radio without referring to the following caution statement.

CAUTION:
This radio contains static-sensitive devices. Do not open your radio unless you are properly grounded. Take the following precautions when working on this unit:

- Store and transport all CMOS/LDMOS devices in conductive material so that all exposed leads are shorted together. Do not insert CMOS/LDMOS devices into conventional plastic "snow" trays used for storage and transportation of other semiconductor devices.
- Ground the working surface of the service bench to protect the CMOS/LDMOS device. It is recommended that you use a wrist strap, two ground cords, a table mat, a floor mat, electrostatic discharge (ESD) shoes, and an ESD chair.
- Wear a conductive wrist strap in series with a 100k resistor to ground. Replacement wrist straps that connect to the bench top covering are Motorola Solutions part number 4280385A59.
- Do not wear nylon clothing while handling CMOS/LDMOS devices.
- Do not insert or remove CMOS/LDMOS devices with power applied. Check all power supplies used for testing CMOS/LDMOS devices to be certain that there are no voltage transients present.
- When straightening CMOS/LDMOS pins, provide ground straps for the apparatus used.
- When soldering, use a grounded soldering iron.
- Handle CMOS/LDMOS devices by the package and not by the leads. Before touching the unit, touch an electrical ground to remove any static charge that you may have accumulated. The package and substrate may be electrically common. If so, the reaction of a discharge to the case would cause the same damage as touching the leads.

Chapter 3

Basic Theory of Operation

The all-band mobile radio is a two-board assembly that consists of a transmitter board and a transceiver board.

The transmitter board consists of the transmitter circuitry, while the transceiver board consists of the receiver, frequency generation unit (FGU), and the controller circuitry.

3.1 General Overview

The mobile radio is a synthesized, fixed-tuned, and all-band radio.

Table 25: Radio Frequency Bands

Frequency Bands	Radio Models
VHF (136–174 MHz)	25 W, 50 W, 100 W
UHF Range 1 (380–470 MHz)	25 W, 40 W, 100 W
UHF Range 2 (450–520 MHz)	25 W, 45 W
700–800 MHz	700 MHz Band: 25 W, 30 W
	800 MHz Band: 25 W, 35 W
900 MHz	30 W

The radio is capable of the following operations:

- Analog operation at 12.5 kHz, 20 kHz, and 25 kHz bandwidths.

  NOTE: 900 MHz Band only operates at 12.5 kHz.

- ASTRO mode operation at 12.5 kHz bandwidth.

APX 2500, APX 4500, and APX 1500 only support mid power radio model. APX 4500Li has rated power of 25 W for all bands. APX 1500 does not support 900 MHz model.

Mobile Radio Assemblies Sections

Radio	Description
O2 Control Head Assembly	The control head assembly contains the following components: • LCD display • User Interface • OMAP 5912 microprocessor For the dash mount configuration, the control head assembly is attached to the controller using a flex and uses SSI to communicate.

Radio	Description
	For the remote mount configuration, the control head assembly is attached to the Control Head Interface Board (CHIB). It uses a flex and a CAN cable to interface with the Remote Control Head to the Transceiver Interface Board (TIB). A flex connects the TIB to the Controller and RF board.
O3 Control Head Assembly	The control head assembly contains the following components: • LCD display • User Interface • OMAP microprocessor • Synchronous Serial Interface (SSI) to Controller Area Network (CAN) protocol • Remote cable to the Transceiver Interface Board (TIB) • Controller and RF board The only difference between Dash mount and Remote Mount is the additional 17' Straight cable.
O5 Control Head Assembly	The control head assembly contains the following components: • LCD display • User Interface • OMAP microprocessor For the dash mount configuration, the control head assembly is attached directly to the controller using a flex and uses SSI to communicate. For the remote mount configuration, the control head assembly is attached to the Control Head Interface Board (CHIB). It uses a flex and a CAN cable to interface the Remote Control Head to the Transceiver Interface Board (TIB). A flex connects the TIB to the Controller and RF board.
E5 Control Head Assembly	The control head assembly contains the following components: • LCD display • User Interface • Kinetics K32H microprocessor For the dash mount configuration, the control head assembly is attached to the controller through a flex. It uses SSI to communicate.

Radio	Description
	For the remote mount configuration, the control head assembly is attached to the Control Head Interface Board (CHIB). It uses a flex and a CAN cable to interface with the Remote Control Head to the Transceiver Interface Board (TIB). A flex connects the TIB to the Controller and RF board.
O7 Control Head Assembly	The control head assembly contains the following components: • LCD display • User Interface • OMAP 5912 microprocessor For the dash mount configuration, the control head assembly is attached to the controller using a flex. It uses SSI to communicate. For the remote mount configuration, the control head assembly is attached to the Control Head Interface Board (CHIB). It uses a flex and a CAN cable to interface with the Remote Control Head to the Transceiver Interface Board (TIB). A flex connects the TIB to the Controller and RF board.
O9 Control Head Assembly	The control head assembly contains the following components: • LCD display • User Interface • OMAP microprocessor For the dash mount configuration, the control head assembly is attached directly to the controller using a flex. It uses SSI to communicate. For the remote mount configuration, the control head assembly is attached to the Control Head Interface Board (CHIB). It uses a flex and a CAN cable to interface with the Remote Control Head to the Transceiver Interface Board (TIB). A flex connects the TIB to the Controller and RF board.
Controller Board	The Controller Board contains the following digital hardware: • Microcontroller • Memory • Logic • Supporting peripherals

Radio	Description
	The digital hardware governs the radio operation, services radio inputs and outputs, and processes voice and data.
CHIB	The CHIB contains the following components: • SSI-CAN FPGA • 16-bit CODEC for audio processing • Class D Audio PA • Controller Area Network (CAN) transceivers. Each CAN transceiver is used to communicate with the RF transceiver, audio, data, and system power-on commands.
Transceiver Interface Board	The TIB contains the following components: • CAN transceivers and audio • Digital routing for accessories The TIB is used with the O3 Control Head for Dash and Remote Mount configuration. The Remote Mount configuration is used with the O5 Control Head.
Radio Frequency Transceiver Board	**Power Amplifier (PA) section** Contains the antenna switch, directional coupler/detector, and amplifier. **Front-End Receiver section** Contains the preselector, low-noise amplifier (LNA), and mixer. **IF section** Contains the receiver intermediate-frequency (IF) amplifier/filter and the digital receiver back-end integrated circuit (IC). **Frequency Generation section** Contains the synthesizer, voltage-controlled oscillators (VCOs), reference oscillator, and receive and transmit buffers.

3.2 Controller Board

The Controller board contains the following elements:

- Voltage regulators and data communication circuitry (RS232, USB, and SB9600)
- Microcontroller, FLASH IC, SDRAM IC, I/O expansion IC
- RF Board interface connector
- CODEC and Audio circuitry
- Power Management and Voltage Regulator IC
- Emergency circuitry

- Secure IC
- Edge connector interface for control head or Transceiver Interface Board (TIB)
- Rear connector for additional accessories (Mid Power Only)
- GPS circuitry
- Edge connector for option board

The followings are the Block diagrams of the controller:

Figure 7: Mobile Controller Block Diagram for APX 5500/6500/7500/6500Li

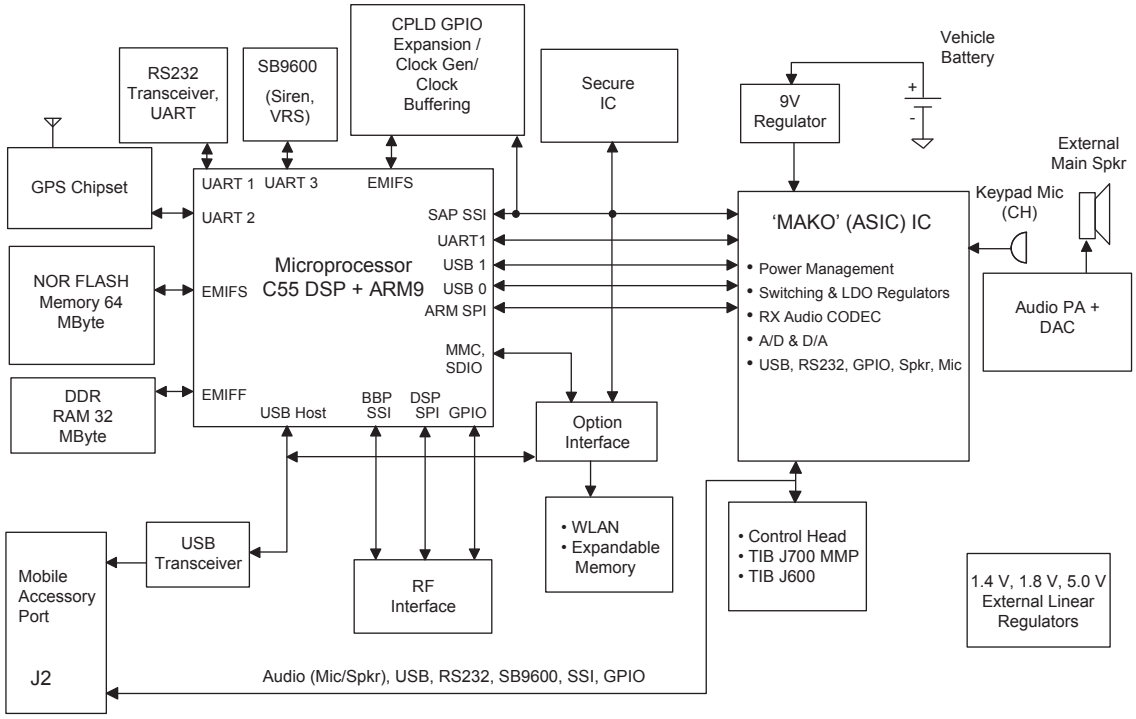
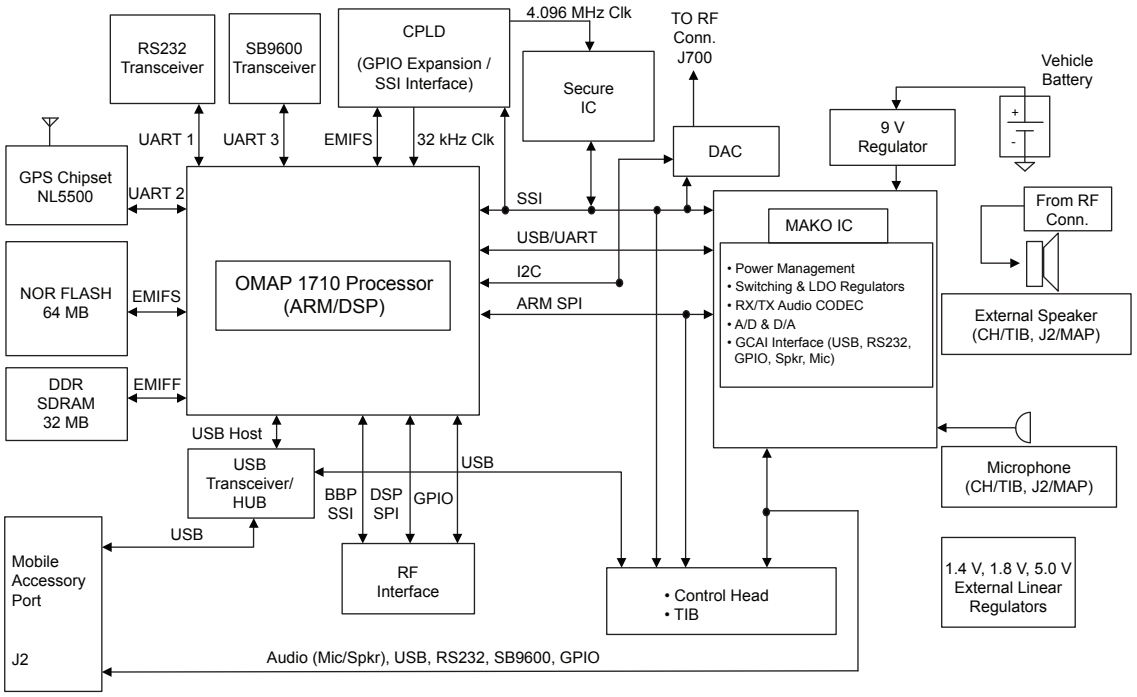


Figure 8: Mobile Controller Block Diagram for APX 2500/4500/4500Li/1500

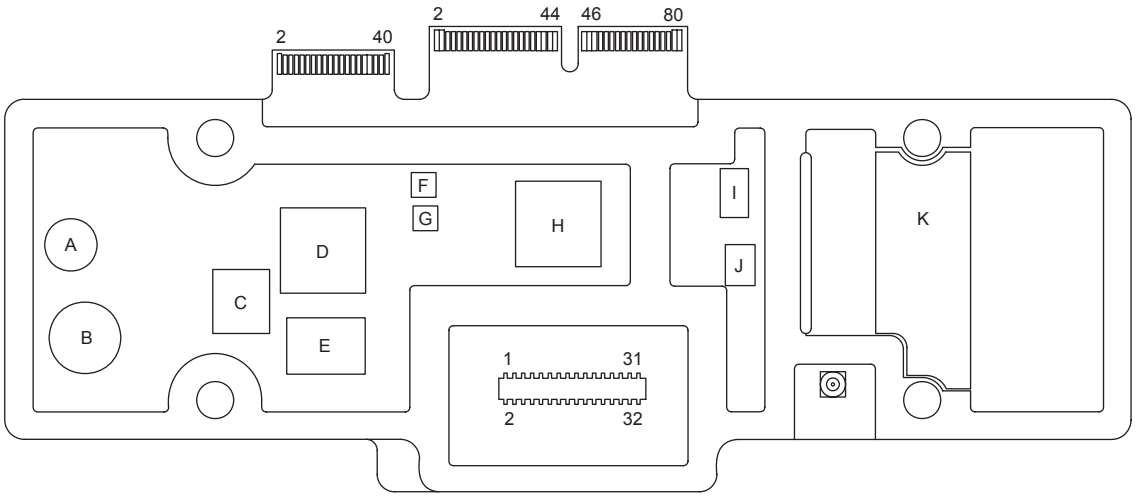


NOTE: APX 1500 does not have Secure IC.

3.2.1
Location

The followings are the controller overlays and the descriptions:

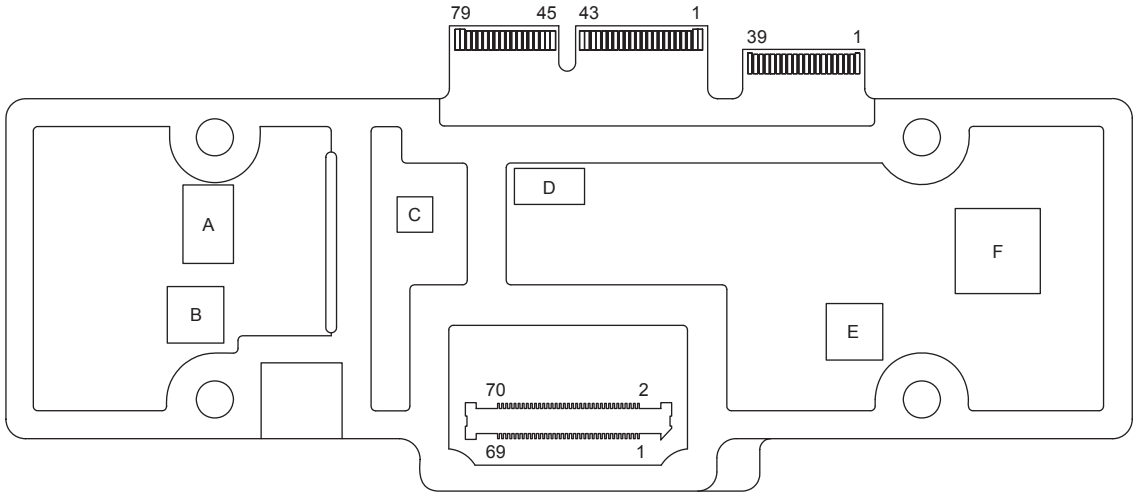
Figure 9: APX 5500/6500/6500Li/7500 Controller Overlay (Side 1)



Component No.	Description
A	3.6 V Switcher Regulator
B	5.45 V Switcher Regulator

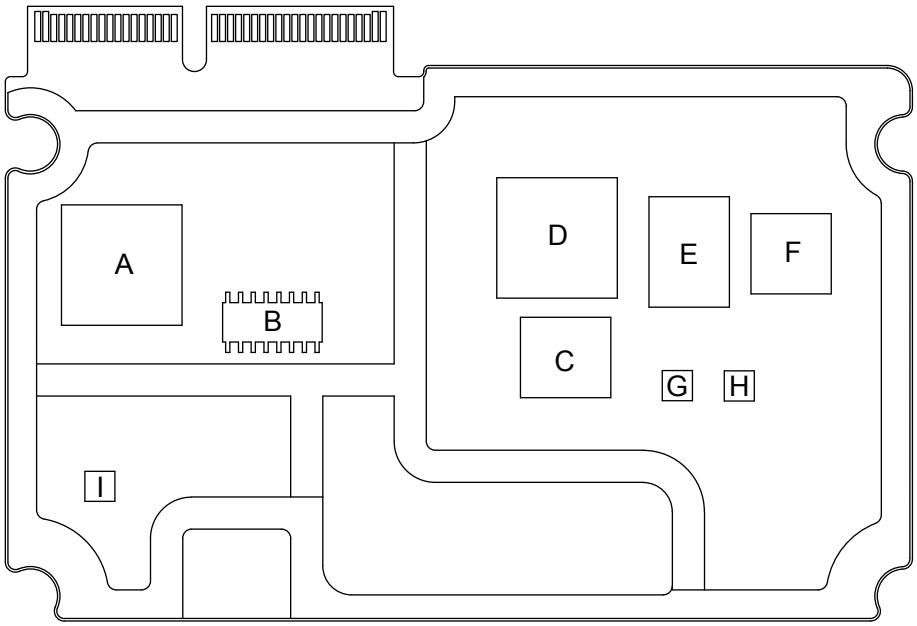
Component No.	Description
C	SDRAM
D	OMAP
E	Flash
F	1.4 V Linear Regulator
G	1.8 V Linear Regulator
H	MACE
I	GPS Regulators
J	GPS IC
K	Audio PA Heatsink

Figure 10: APX 5500/6500/6500Li/7500 Controller Overlay (Side 2)



Component No.	Description
A	Audio PA
B	9.3 V Linear Regulator
C	Audio DAC
D	RS-232 Transceiver
E	CPLD
F	Mako

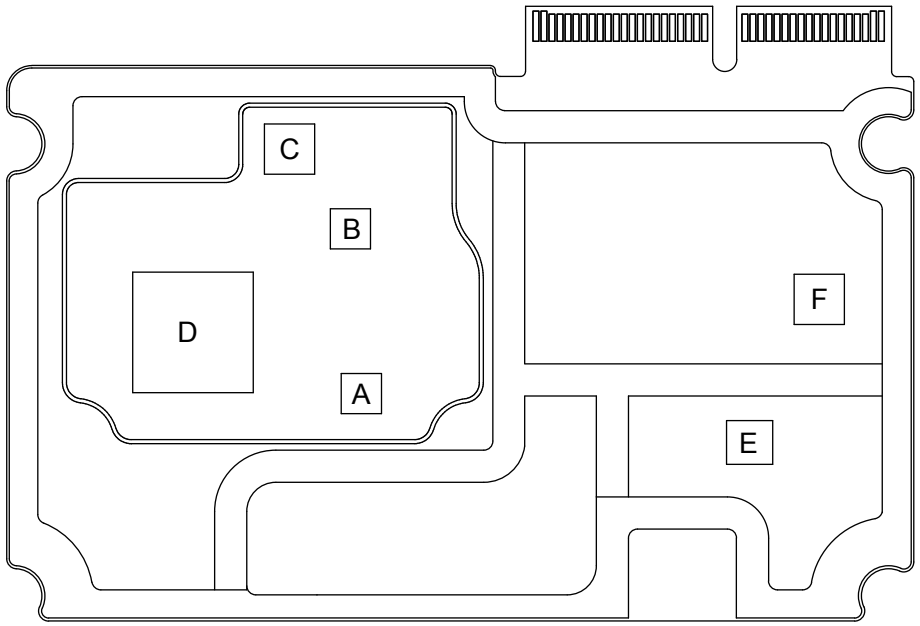
Figure 11: APX 2500/4500/4500Li/1500 Controller Overlay (Side 1)



NOTE: APX 1500 does not have MACE. It is not necessary for all other radios such as APX 2500/4500/4500Li to have MACE.

Component No.	Description
A	MACE
B	RS-232 Transceiver
C	SDRAM
D	OMAP
E	Flash
F	CPLD
G	1.4 V Linear Regulator
H	1.8 V Linear Regulator
I	GPS Regulators

Figure 12: APX 2500/4500/4500Li/1500 Controller Overlay (Side 2)



Component No.	Description
A	3.6 V Switcher Regulator
B	5.45 V Switcher Regulator
C	Audio DAC
D	Mako
E	GPS IC
F	USB HUB

3.2.2
Microprocessor/Memory

The ‘core’ of the controller consists of three parts which are microprocessor/DSP, NOR-FLASH IC, and
DDR-SDRAM IC.

NOTE: The three parts are highly susceptible to Electrostatic Discharge (ESD) and moisture damage. Extreme care is advised.

3.2.2.1
Microprocessor

The microprocessor consists of an ARM-based controller and a C55-based DSP that communicates with the memory ICs through a 16-bit data bus.

The microprocessor also communicates to peripheral ICs on the main board through an SSI, I2C and SPI bus. This microprocessor contains a fixed amount of one-time programmable ROM and a small section of RAM. The microprocessor does not contain the customer codeplug settings as programmed in the Customer Programming Software (CPS) or the firmware as installed at the factory. The purpose of this IC is for interpretation and processing of the content inside the FLASH IC and execute out of the SDRAM IC. This part can be replaced without the need to reflash the radio.

The followings are the seven clocks supplied to the controller microprocessor:

- 16.8 MHz reference/timing clock for RF modulation processing
- 32 kHz real-time clock (CKIL)
- 12 MHz operating clock
- 20 kHz RX frame-sync clock
- 84 kHz TX frame-sync clock
- 1.2 MHz RX data clock
- 4.2 MHz TX data clock

The microprocessor also generates 1.536 MHz data clock and an 8 kHz frame-sync clock digital audio bus clocks.

3.2.2.2
FLASH IC

The FLASH IC is the firmware and codeplug storage IC.

Programming this IC is accomplished using one of the programming cables and input paths listed in Table 1:

CAUTION: If during a flash upgrade, the radio power becomes interrupted and the radio fails to recover, the radio must be reflashed utilizing the force fail circuitry. An explanation of the circuitry can be found in Option Board Assembly on page 83 and the service procedure can be found in Recommended Test Equipment on page 117.

3.2.2.3
SDRAM IC

The SDRAM IC is used by the microprocessor to execute code downloaded from the FLASH IC, and to perform its memory operations and is not upgradeable to a larger density.

3.2.3
Voltage Distribution/Power On/Off

Figure 13: Voltage Distribution/Power On/Off Diagram for APX 5500/6500/7500/6500Li

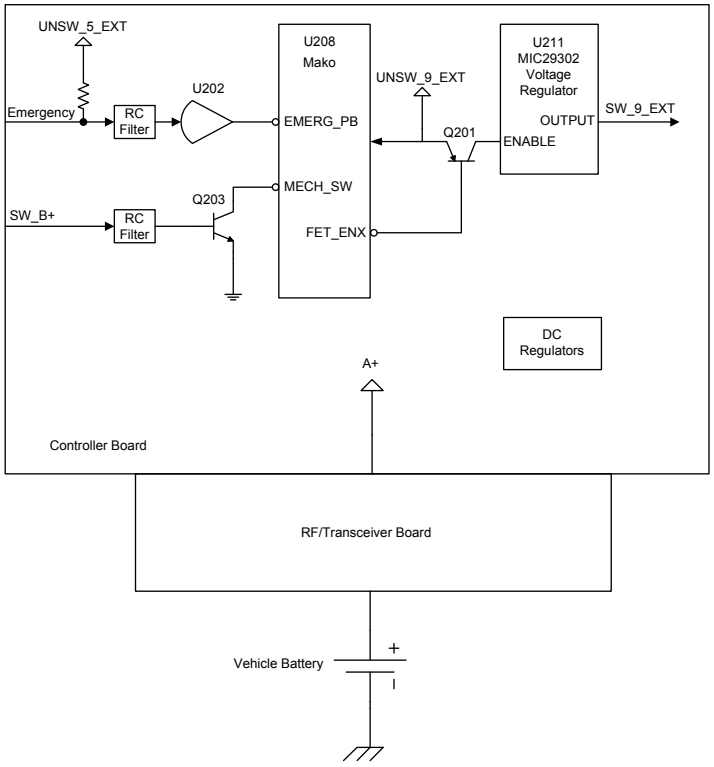
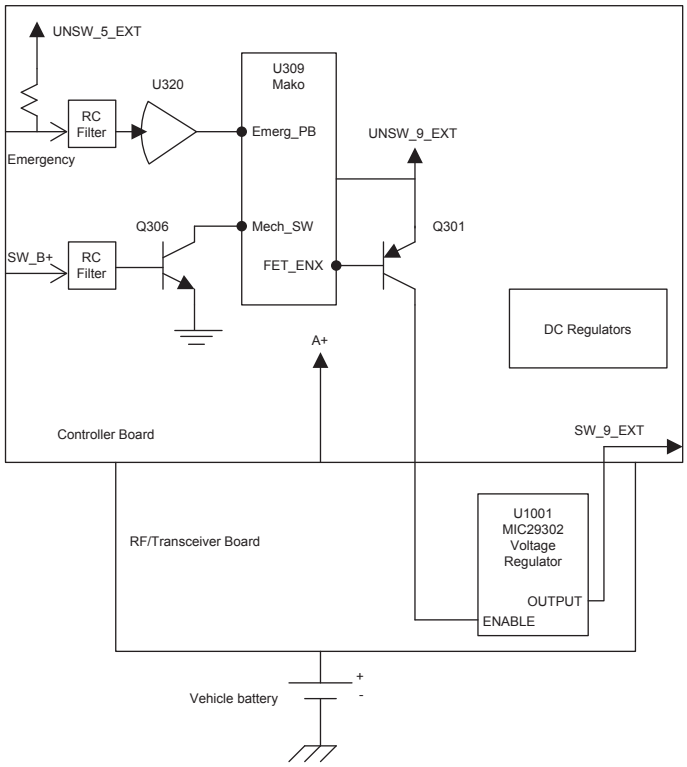


Figure 14: Voltage Distribution/Power On/Off Diagram for APX 2500/4500/4500Li/1500



3.2.3.1

Voltage Distribution for Controller and RF Board

The APX mobile radios are powered by a 12 V vehicle battery (negative ground), or a AC-to-DC desktop power adapter, and enters at the rear of the radio transceiver at a dedicated 2-pin DC connector.

This raw voltage, referred to as “A+”, is routed past a shunt clamping zener diode and into the RF board. The voltage then splits to some components on the RF board and into a Load Dump “Over Voltage Protection” circuit. The output from this circuit clamps the voltage to a fixed maximum level, which is then supplied to both the remainder of the RF board circuit sub-sections and into the controller board circuit sub-sections.

3.2.3.2

Power On/Off

There are four methods that can be used to turn the radio on and off which are power button on the control head, power button on an accessory connected to the Mobile Microphone Port (MMP) of the control head, Ignition sense (ACC) line, and emergency.

Power Button

The power button turns the radio on and off unless the codeplug is set to ignition required and the ignition signal is not present.

Accessory with Power Button

An accessory that has power-on functionality can be connected to the control head MMP port. The power button on the accessory functions the same as the control head power button. Power-on functionality is not available at the Transceiver Interface Board (TIB) MMP.

Ignition sense (ACC) line

Ignition turns the radio on in two cases. First, the codeplug is set to ignition required and the radio was in the “ON” state when ignition was removed from the radio. Second, the codeplug is set to “soft power off”. “Soft Power Off” is an “OR” function between the power button and the ignition signal. If either the ignition signal is asserted or the power button is pressed, then the radio turns on.

Emergency

The emergency footswitch connected to pin 15 of the Mobile Accessory Port (MAP) located on the rear of a mid-power transceiver and the rear of a remote mount control head turns the radio on if “emergency power-on” is enabled in the codeplug.

The control head power button, MMP power button, Ignition sense (ACC) line connected to a remote control head, and emergency connected to a remote control head are all described in the control head manual. In the dash mount configuration, Ignition sense (ACC) and emergency are connected to the transceiver and handled by circuits on the controller board.

The transceiver regulators are controlled by the ‘MAKO’ (ASIC). This IC has a Power Management Controller (PMC) state machine that monitors two inputs to the ‘MAKO’ (ASIC), MECH_SW and EMERG_PB. The hardware for the state machine is powered by the UNSW_9 regulator.

To turn the radio on, the control head, or TIB in the remote mount case, applies SW_B+ to the controller board. This signal is connected to the ‘MAKO’ (ASIC) pin MECH_SW through an inverting isolation transistor. When MECH_SW is pulled low by this transistor, the state machine enters the “ON” state, turning on the transceiver regulators. When SW_B+ is de-asserted, causing MECH_SW to go high, a 125 ms timer is started. When the timer expires, the PMC state machine enters the “OFF” state. System software can extend this time by sending periodic commands to the ‘MAKO’ (ASIC) IC.

3.2.3.3
Emergency

The emergency feature allows the radio to power-up and send an alert over the system by pressing a footswitch.

The feature must be enabled in the codeplug. In addition, emergency power-up is not available using the control head orange programmable emergency button. The emergency footswitch is a closed switch that connects to J2 pin 15. The emergency signal is pulled to 5 V on the controller board. When the emergency footswitch is pressed, the switch opens allowing the line to be pulled high. To reduce the chances of false triggering due to noise, a comparator with hysteresis is used. The comparator output is an open drain output and connects to the ‘MAKO’ (ASIC) EMERG_PB signal.

When EMERG_PB is pulled low by the comparator output, the PMC state machine enters the “ON” state. Software must turn the system off by sending a command to the ‘MAKO’ (ASIC). Specifically, an emergency flag must be cleared.

In the remote mount configuration, the emergency footswitch is connected to the MAP connector on the back of the control head assembly. The emergency footswitch can be connected to the J2 connector if the TIB is modified. A jumper is present on the TIB that grounds J2 pin 15. This jumper must be removed.

3.2.4
Audio Circuitry

This topic covers the RX audio path and TX audio path.

3.2.4.1
RX Audio Path

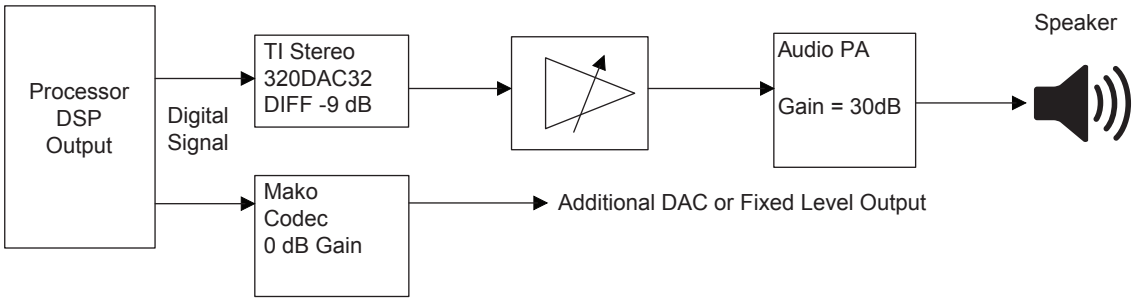
The receive audio path consists of the following main components:

- Texas Instruments OMAP 1710
- Texas Instruments Audio DAC TLV320DAC32
- Mako IC
- NXP Audio PA TDA8932

The Digital audio signal comes from the processor using SSI protocol. The Audio SSI bus is routed to Mako IC D/A converter (DAC) and the TI DAC. The Mako DAC converts the SSI digital data to analog. The analog data from the Mako has a fixed level output which is used for the receive filtered audio and universal speaker signals.

The TI DAC also converts SSI digital audio to analog audio which in then routed to the volume control section of the DAC. Analog audio is attenuated based on the volume setting. The TI DAC volume control uses I2C bus which is driven by the controller. The output of the TI DAC is routed to the Class D Audio PA TDA8932. The Audio PA converts the analog signal to a PWM output, it also adds 36 dB of gain. The output low pass filter (LC), filters out the Audio PA switching frequency before the audio is routed to the speaker output.

Figure 15: Audio Receive Path in APX mobile radio Transceiver



3.2.4.2

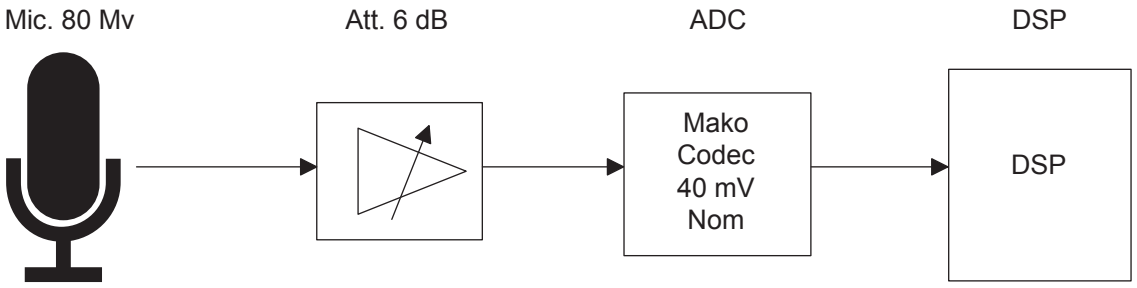
TX Audio Path

The transmit audio path consists of the following main components:

- Texas Instruments OMAP 1710
- Mako ADC
- Atten/PreAmp.

Analog audio comes from the external Microphone attached to the radio using the control head mic port or the rear accessory connector J2 (Mic_Hi or Aux_Mic). Analog audio is attenuated by 6 dB and is then routed to the Mako. Mako converts the analog audio to digital and sends it to the main processor using the Audio SSI bus. OMAP processes the audio which is converted to Baseband audio and routed to the RF board.

Figure 16: Audio Transmit Path in APX mobile radio Transceiver



3.2.5

Secure

The controller board is able to perform secure option functions through the MACE IC.

The CODEC supplies the DSP (part of OMAP) with audio similar to digital mode. When a secure signal has been selected or detected, it is diverted to the MACE through the SSI lines. The conversion between
non-encrypted (red) and encrypted (black) occurs within the MACE.

Power

The MACE shares the same 1.8 V supply as the OMAP. The volatile memory within the MACE is supplied by a combination of one or two capacitors. These caps are charged through a blocking diode and regulators derived typically from a power source such as the vehicle battery.

Clock

The 24.576 MHz clock originating at Mako is divided down to 4.096 MHz on the CPLD to supply clock and frame sync to the MACE. See Controller Board on page 67.

Keyloading

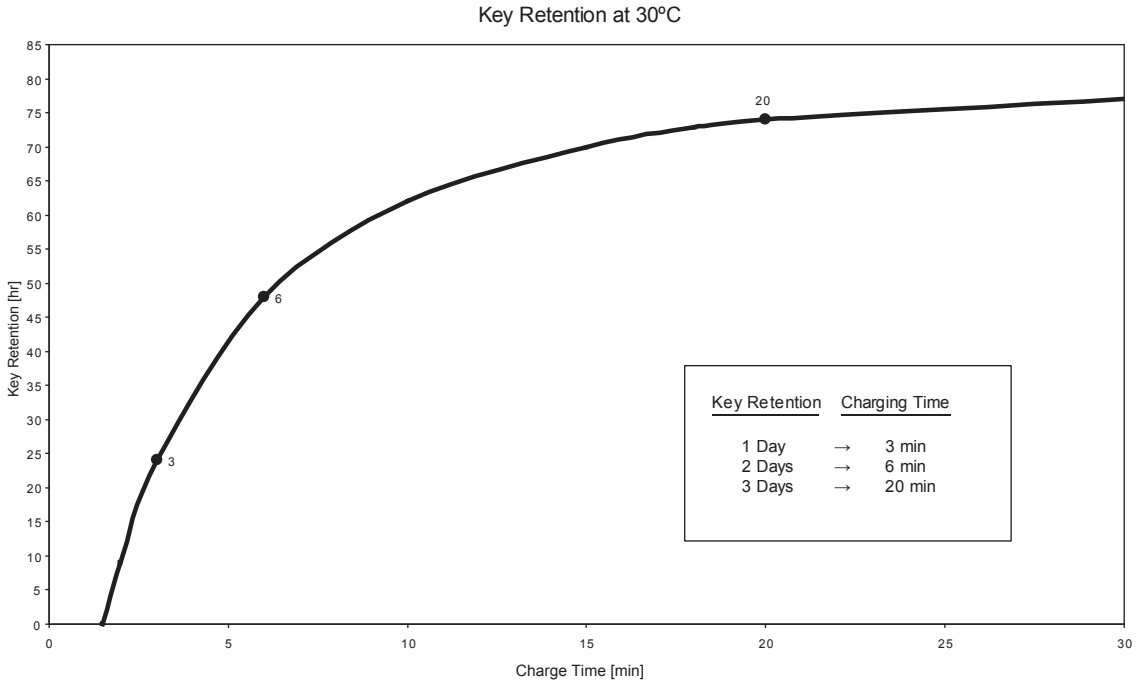
See Motorola Advanced Crypto Engine Secure Options on page 159. The KEYLOADER signal comes in on MMP pin 9 of the control head or TIB J700 connector. It connects directly to the MACE. There is an algorithm in the MACE which detects and stores the key as long as the radio is powered.

Tamper and key retention

The MACE has the option of infinite key retention using the same electrically erasable memory as the operating code. The key can be disabled by several means to avoid compromise. A tamper switch detects mechanical intrusion. A supply maintains the static memory when all power to the transceiver is removed. This volatile key retention option holds the key for at least 30 seconds on the discharge of an on board capacitor. A three-day key retention option board (see Option Board Assembly on page 83), adds a much larger capacitor to increase the time for storage and/or shipping. In both cases, the loss of power corrupts the static RAM.

The 3-day key retention capacitor charge time (the duration when radio is plugged into a power supply/battery) versus key-retention duration is shown in Figure 17: Key Retention Graph on page 78.

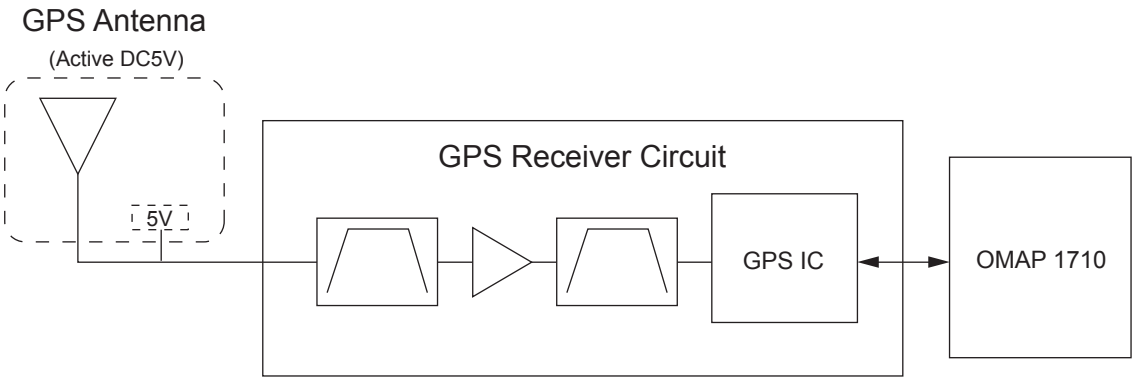
Figure 17: Key Retention Graph



3.2.6
GPS Overview

When and where to use:

Figure 18: GPS Architecture



The GPS architecture employs a single chip GPS receiver which decodes GPS signals at 1575.42 MHz. It is capable of producing a final position solution including full tracking and data decode capability. The GPS receiver operates in the autonomous mode only.

The GPS receiver is setup in an autonomous one track always (OTA) mode, also known as continuous navigation. This means the GPS continuously tracks satellites for as long as the radio is powered to ensure the best possible accuracy. In the event the radio loses visibility of the satellites due to terrain or environmental factors such as driving through a tunnel or in a parking garage, the GPS temporarily loses its position fix. The GPS then begin to reacquire the signal and compute an updated position once the radio has moved back into an environment where GPS signals are present.

The user is able to view the current latitude, longitude, and time or date stamp on the radio display. The radio can also be configured to send its' location to the system at predetermined intervals (LRRP). Depending on system options, the user may be able to enable or disable the GPS receiver.

If the GPS receiver is unable to acquire a position try the following steps.

Procedure:

1. Make sure the unit is in an open sky environment to ensure the presence of GPS signals (min 5 satellites in view at nominal power levels of -130 dBm).
2. Reset the radio. If a position fix does not occur within two minutes go to step 3.
3. Disconnect the GPS antenna and ensure the center conductor on the antenna is not shorted to ground. If so, replace the GPS antenna.
4. Measure the voltage on the GPS SMA connector located on the radio and ensure 5 V is present. If 5 V is not present, send the radio in for repair.

NOTE: If step 1 to step 4 have been followed and the GPS still does not obtain a position fix, refer to the Detailed Service Manual for further instructions.

CAUTION: These custom connectors are optimized to meet voltage and current requirements for existing accessories and for the compatible flexes that are used with the APX 7500 radio. Inserting non-Motorola Solutions parts or flexes into these connectors is not recommended. Failure to do so can result in equipment damage.

3.2.7
Serial Interfaces

The following figures shows external serial interfaces supported by the APX7500/APX 6500 transceiver for both dash and remote mount operation.

Figure 19: Dash-Mount Configuration

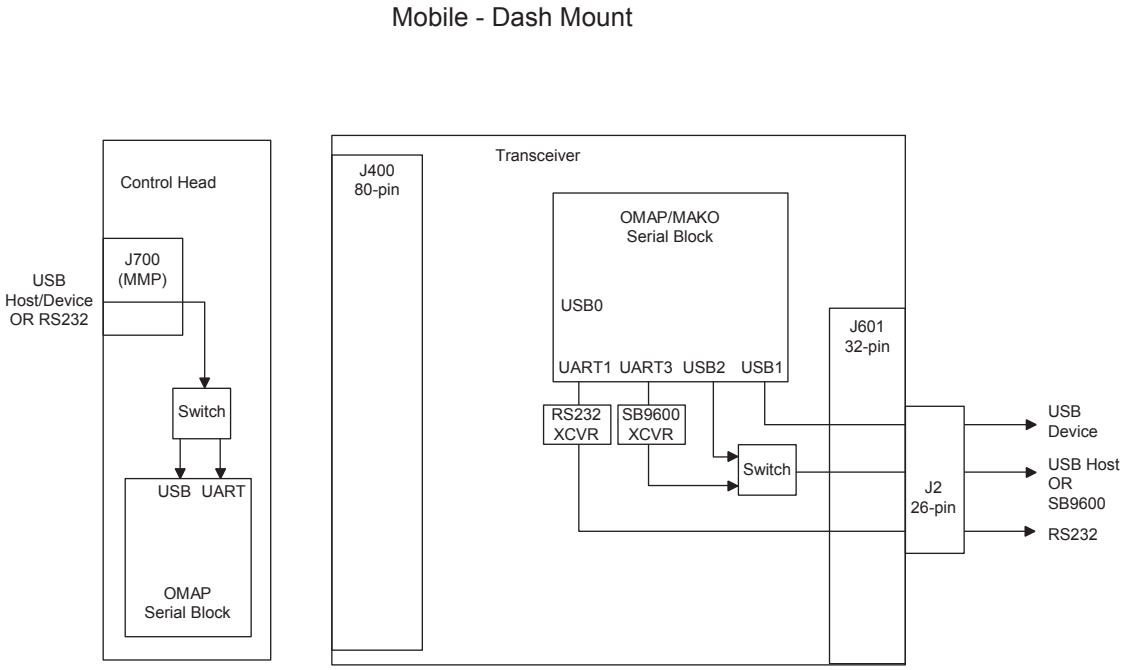


Figure 20: Remote-Mount Configuration for APX 5500/6500/7500/6500Li

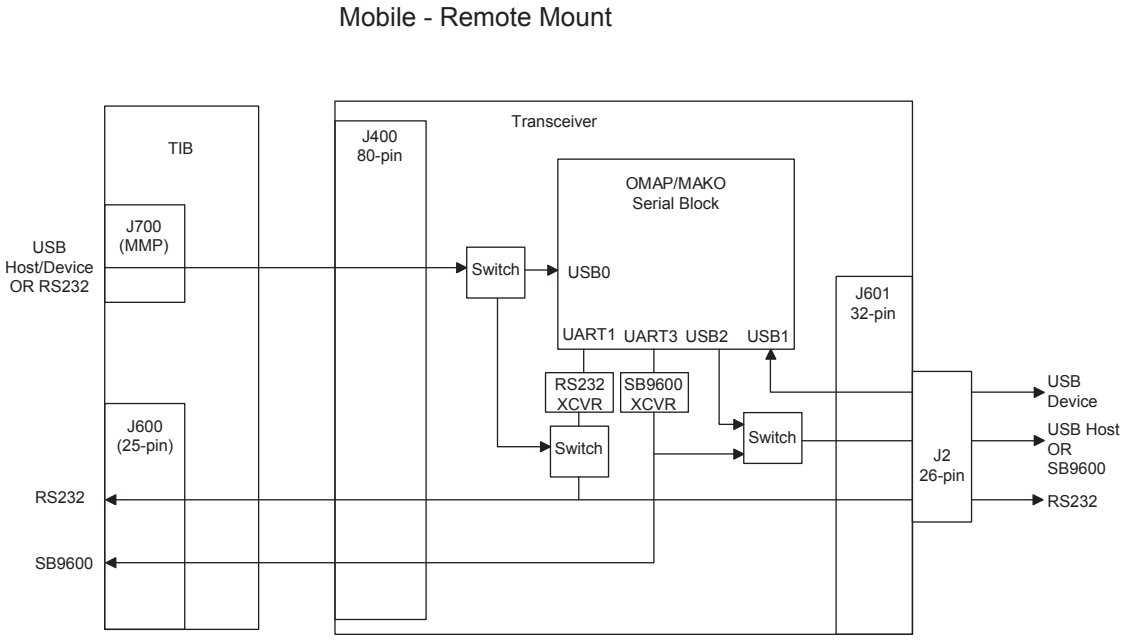
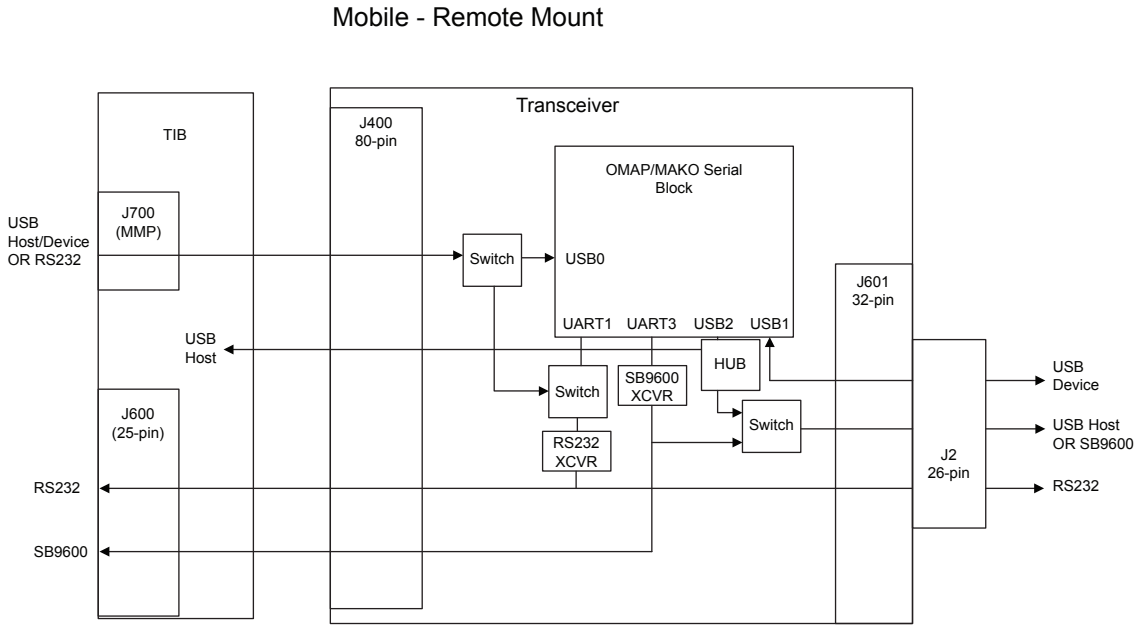


Figure 21: Remote-Mount Configuration for APX 2500/4500



The mid-power radio has RS232, USB Device, USB Host, and SB9600 available at the rear 26-pin J2 connector. Both mid-power and
high-power radios have RS232, and USB Device/Host, available at the TIB external connectors J700 or J600. Many of the accessories that connect to the J700 and J2 connectors are identified through the 1-Wire ® serial protocol. This information tells the controller which serial bus to configure for the accessory. The 1-Wire ® IC is typically embedded in the cable or accessory for this purpose.

NOTE: The serial interfaces at the J700 MMP connector in the dash mount is not connected to the transceiver controller, but rather to circuitry on the control head.

There are hardware design limitations that limit the number of serial interfaces that can be used simultaneously.

- RS232 – This serial interface is available at either the J2 (rear), J600 (TIB) connectors, or at the J700 (TIB) connector. The J2/ or J600 interface is compliant with industry-standard 12 V RS232 logic and is the default selection when no 1-Wire ® accessory is attached to the J700 connector. An RS232 device can be used at either J600 or J2 (but not simultaneously). If a 1-Wire ® compliant RS232 accessory is attached to the J700 connector, then the bus is no longer supported at J2/J600. The J700 RS232 interface is at 5 V logic, while the RS232 cable contains the voltage translation circuitry to make the bus 12 V compliant.
- SB9600 – This is a Motorola Solutions proprietary bus used to communicate with certain legacy accessories. The bus is available at both the J2 and J600 connectors by default. This bus can also be configured as a second UART/RS232 bus (at 5 V logic level) at both connectors, as a future feature. This configuration would required a voltage-translation circuit in the cable, similar to that of the J700 RS232 1-Wire ® accessory or cable. This would allow for use of both RS232 interfaces simultaneously at either J2 or J600.
- USB – USB Host and Device functionality are available at the J700 MMP connector on TIB. The functionality is again determined by the type of accessory or cable identified by the 1-Wire ® interface. USB Device is also a dedicated interface at the J2 connector by default. In addition, USB Host can be optionally configured at the J2 connector via the SB9600 interface (the buses share common pins). The SB9600 bus is configured by default, but USB Host is configured when a 1-Wire

® compliant USB Device accessory or cable is attached to the J2 connector. USB Host is also available for TIB through the J400 CH/TIB edge connector, for APX 2500 /4500/4500Li.

NOTE: If a USB cable is attached to the TIB J700 connector, the RS232 link at the J2/J600 can still be used. The J2 USB Host and Device interface can also be used if the J700 USB interface is for Host only

In addition to the serial interfaces, there are several audio and digital inputs or outputs supported at J2, J700, and J600 connectors of the transceiver. Digital inputs or outputs include the following:

- PTT – Active low input signal that causes the radio to transmit; available at J2 and J600.
- IGNITION – Active high input signal tied to vehicle ignition sense (ACC) for configurable system power-up; available at J2 and J600. Can also be used at the remote control head.
- EMERGENCY – Active high input signal activated by an optional foot-switch accessory, for configurable system power-up; available at J2 and J600.
- MONITOR – Active low input signal used as a microphone HUB detection, for override of PL signal during receive; available at J2.
- CHAN_ACT – Active low output used to indicate presence of a qualified receive audio signal; available at J2.
- VIP OUT 1 & 2 – Configurable control signals driven by a DEK or equivalent accessory box attached at the J600 connector, to control or enable various functions such as Horn and lights attached at the J2 connector.

The following audio signals exist on the radio, along with their locations:

- AUX_MIC – Optional microphone audio input; available at J2 and J600.
- MIC_HI – Primary dash-mount microphone audio input; available at J700.
- AUX_TX – Optional microphone audio input; available at J600.
- RX_FILT_AUDIO – Line-level speaker output; available at J2 and J600.
- MMP_SPKR – Line-level speaker output; available at J700.
- SPKR+, SPKR- – Primary amplified speaker outputs, available at J2 and J600.

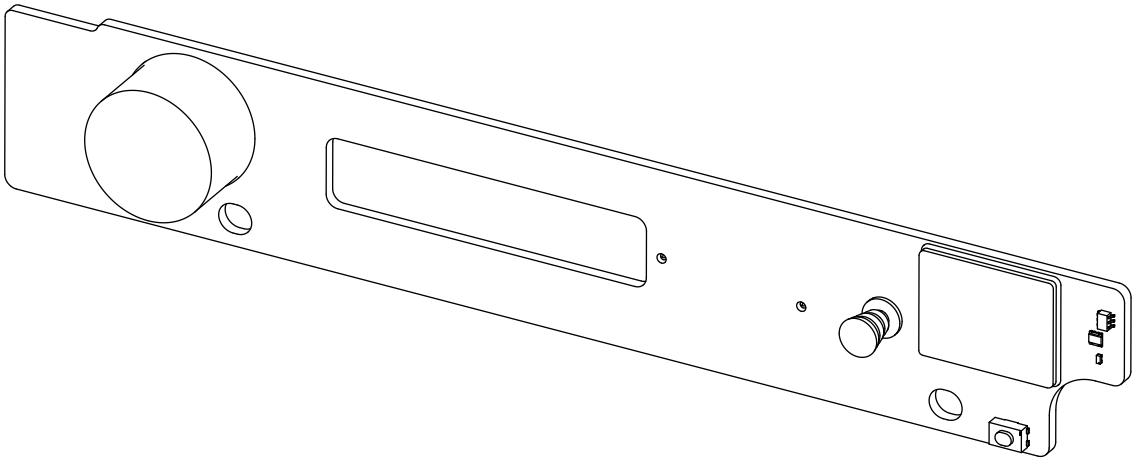
3.2.8
Accessory Power

SW_B+ is sourced from the control head in the dash mount configuration and the TIB in the remote mount configuration.

SW_B+ enters the transceiver through the front edge-connector J400. Applying SW_B+ to the front connector turns the transceiver on. SW_B+ is also routed to rear connector J2 to provide power for accessories. Two ground pins are available on rear connector J2 and four ground pins are available on the front-connector.

3.3
Option Board Assembly

Figure 22: Option PCB with Memory and 3-Day Secure Key (MHLN6999_S)



There are 2 orderable option board assemblies available for both dash and remote mount configurations:

- GA00239AA containing the MHLN6999_S Memory board with 3-day secure key retention
- GA00238AA containing the MHLN7000_S Memory board

Both option boards contain a 1G managed NAND IC and Force fail circuitry. The MHLN6999_S contains circuitry for 3-day key retention.

NOTE: These option boards are not in use for APX 2500/4500/4500Li/1500.

3.3.1
Managed NAND

The managed NAND device is connected to the system processor using the Multimedia Card (MMC) interface. The bus runs at 25 MHz and is 4-bits wide.

3.3.2
Forced Fail Functionality

The transceiver ships with a boot application that either executes normal radio firmware, or downloads firmware to the radio through USB.

The boot application stops and wait for a download if the firmware is corrupted, from a previous download for example, or if the user forces the radio into boot mode. The mechanism to force the radio into boot mode is located on the standard option board. Pressing the button labeled “Force Fail” on the option board then turning on the radio causes the boot application to not execute the radio firmware and instead wait to download new firmware. When boot application is in this mode, the LED on the option board labeled “TRAP” lights up.

3.3.3
3-Day Secure Key Retention

0.47 F capacitor is used to maintain power to the secure IC when power is removed from the radio. This allows any programmed keys to be maintained for approximately three days. Without this capacitor, key retention time is roughly 30 seconds.

3.4 Control Heads Assembly

This section describes the APX mobile radio control head assembly.

- O2 control head - Consists of the main board, option board, LCD display module, and mechanics that include the multifunction knob and user interface buttons. Circuits on the main board include the OMAP microprocessor, FLASH memory, DDR-SDRAM memory, and the control head voltage regulators. In dash mount the control head assembly is mounted directly to the transceiver unit. In remote mount, the control head communicates to the TIB on the transceiver unit using the Controller Area Network (CAN) protocol.
- O3 control head - Consists of the main board, keypad flex, side button flex and LCD display module. Circuits on the main board include the OMAP microprocessor, FLASH memory, SDRAM memory, FPGA, CAN transceivers, AVR Power On/Off circuit, and the control head voltage regulators. The control head is connected to the transceiver unit using a CAN cable and this applies to Dash mount and Remote mount. The control head communicates to the TIB on the transceiver unit using the Controller Area Network (CAN) protocol.
- O5 control head - Consists of the main board, keypad boards, LCD display module, and mechanics that include the volume knob, mode knob, and user interface buttons. Circuits on the main board include the OMAP microprocessor, FLASH memory, SDRAM memory, and the control head voltage regulators. In dash mount the control head assembly is mounted directly to the transceiver unit. In remote mount, the control head assembly is mounted to the Control Head Interface Board (CHIB).
- E5 control head - Consists of the main board, keypad boards, LCD display module, and mechanics that include the volume knob, mode knob, and user interface buttons. Circuits on the main board include the K32H microprocessor, FLASH memory, LPDDR2 memory, and the control head voltage regulators. In dash mount the control head assembly is mounted directly to the transceiver unit. In remote mount, the control head assembly is mounted to the Control Head Interface Board (CHIB).
- O7 control head - Consists of the main board, bluetooth board, LCD display module, and mechanics that include the multifunction knob and user interface buttons. Circuits on the main board include the OMAP microprocessor, FLASH memory, DDR-SDRAM memory, and the control head voltage regulators. In dash mount the control head assembly is mounted directly to the transceiver unit. In remote mount, the control head communicates to the TIB on the transceiver unit using the Controller Area Network (CAN) protocol.
- O9 control head - Consists of the main board, LCD display module, and mechanics that include the volume knob, mode knob, and user interface buttons. Circuits on the main board include the OMAP microprocessor, FLASH memory, DDR-SDRAM memory, and the control head voltage regulators. The control head communicates to the TIB on the transceiver unit using the Controller Area Network (CAN) protocol.

3.4.1 OMAP Microcontroller

The Texas Instruments OMAP microcontroller is used to perform control head operations.

The user interface for O5, consisting of nine buttons, the volume knob, and 16 position mode knob and for O3 consisting of 32 buttons is read by OMAP and the input is passed to the transceiver unit through the Synchronous Serial Interface (SSI). In the dash mount configuration for the O5, the OMAP SSI bus is connected directly to the transceiver microprocessor SSI bus. In remote mount for O5, the OMAP SSI bus is converted to the Controller Area Network (CAN) protocol by the CHIB. For the O3 Dash mount and remote mount configuration, the SSI is passed to the FPGA unit where it is converted to the CAN protocol and sent to the CAN Transceivers which transmits the CAN signal over the CAN cable. The CAN signal is received by the Transceiver Interface Board (TIB), which converts the signal back to SSI and routes the signal to the transceiver microprocessor. OMAP uses two clocks, a 32kHz clock supplied by an external oscillator and a 12 MHz clock supplied by an internal oscillator.

The volume knob and 16 position frequency knob is read by OMAP. The user interface for O9, consisting of 16 buttons would be mapped to the OMAP keypad interface module through a column or row matrix as well. The rest of the 30 keys are mapped through an external keypad encoder. In the remote mount configuration for O9, the OMAP SSI bus is converted to the Controller Area Network (CAN) protocol by FPGA unit. The CAN signal is received by the Transceiver Interface Board (TIB), which converts the signal back to SSI and routes the signal to the transceiver microprocessor.

The user interface for O2 consisting of 9 keys is mapped to the OMAP keypad interface module through a column or row matrix. In the dash mount configuration for the O2, the OMAP SSI bus is connected directly to the transceiver microprocessor SSI bus. The user interface for O7 consisting of 24 keys is mapped to the OMAP keypad interface module through a column or row matrix. In the dash mount configuration for the O7, the OMAP SSI bus is connected directly to the transceiver microprocessor SSI bus. In remote mount for O7, the OMAP SSI bus is converted to the Controller Area Network (CAN) protocol by the CHIB.

3.4.2
Kinetis K32H Microcontroller

The E5 Control Head uses the Kinetis K32H microcontroller from NXP to perform the main operations.

The user interface for E5 consisting of buttons, volume knobs, LCD display, LED indicators, LED backlights, and input/output signal are controlled by the processor and then is passed to the transceiver unit via the Synchronous Serial Interface (SSI). In the dash mount configuration for the E5, the Flex IO bus configured to SSI is connected directly to the transceiver microprocessor's SSI bus. In remote mount for E5, the SSI bus is converted to the Controller Area Network (CAN) protocol by the CHIB. The K32H microprocessor uses a single external clock of 24 MHz crystal.

3.4.3
Field-Programmable Gate Array (FPGA)

The FPGA implements an SSI to CAN-protocol translation, which is used to provide a remote link between the Control Head and radio transceiver, through the TIB, in a remote mount configuration.

Each processor uses SPI to configure the FPGA at each startup (the OMAP or K32H for E5 programs the CHIB's FPGA, and the radio transceiver microprocessor programs the TIB's FPGA). Once the FPGA is programmed, each processor uses the SSI bus to send or receive data to or from the FPGA, clocked at 1.536 Mhz and synchronized at 8 kHz. The FPGA converts this SSI data into a CAN-protocol, which is input into two CAN transceivers (digital data stream and digital audio stream), and out special CAN cables to or from the O3 control head, the TIB, or the CHIB based on control head configuration. The third CAN Transceiver (power on/off/reset) is not controlled by the FPGA. For the O3, there is a 10 foot coiled CAN cable, and a 17 foot straight extension cable. For the O2, O7, O5, E5, and O9, there are various fixed-length CAN cables (3 meters to 40 meters).

3.4.4
Controller Area Network (CAN) Transceivers

There are a total of 3 CAN Transceivers located on the O3 Control Head, 3 on the TIB, and 3 on the CHIB.

CAN1 is used for digital Audio, CAN2 is used for digital Data and CAN3 is for digital Power ON/OFF/RESET pulses. If an O5 control head is used, a TIB and CHIB must be present. If an O3 control head is used, only a TIB must be present, since the O3 control head has the CAN transceivers located on its PCB's. The CAN bus provides a 1MB/s data link. Only the list of approved Motorola Solutions CAN cables are to be used for any remote mount installations.

For the O2, O7, E5, and O9 control head, the CAN provides the needed data and audio interface between the transceiver and control head for remote mount connectivity. FPGA unit is be the OMAP (K32H for E5 control head) and CODEC interconnect for digital and audio data respectively. SPI is

used to configure the FPGA unit, and GPIO is used for status and interrupt functionality. Three CAN transceivers are needed because the audio data uses its own transceiver, digital data uses another CAN transceiver and PWR on/off will use one more CAN transceiver. The data from the three CAN transceivers is sent over a network type cable containing 6 twisted pair sets of wire. There are two CAN interface connectors on the control head: one for the main network cable that is connected to the transceiver; and another for a parallel control head to interface on the CAN bus.

3.4.5
Power Management

The remote mount radio system uses a CAN protocol for turning-on, turning-off, and resetting the entire system.

For normal operation, you will never have only part of the radio system operating. Either it is “all on” or “all off”. Regarding specific regulator aspects of the radio, the Control Head assembly contains a 5 V switching regulator that is supplied by A+. When enabled, the 5 V regulator output is applied to a TI power management IC.

For the O5 Control Head, A+ is also applied to a 2.8 V regulator and a MOSFET that is used as a switch to provide “switched B+” to the radio transceiver in dash mount configuration. The ATMEL AVR, advanced RISC microcontroller is used on the O3, O5, E5, and TIB to power-on, power-off, and reset the entire radio system. It has multiple inputs for determining the correct state of the radio as well as inputs to detect a request to change the state of the radio, either externally, or through processor GPIOs. Refer to the *Detailed Service Manual* for specifics. The TI power management IC provides three voltages that are used by the control head, which are 3.3 V, 1.8 V, and 1.5 V. The 3.3 V supply is primarily used by the USB transceiver internally to OMAP and FPGA. As for E5, the BD71827 power management IC from ROHM provides to the control head with 1.8 V, 2.8 V, and 3.3 V. The 1.8 V supply is used by the K32H microprocessor. The 3.3 V supply and 2.8 V supply are used the FPGA general purpose inputs and outputs (GPIOs) in addition to most of the analog circuits on the main board. The 1.8 V supply is used by the FLASH and SDRAM memory modules. The 1.5 V supply is used by the OMAP core and FPGA core. The AVR also provides a watchdog function to the control head both OMAP & K32H. The watchdog function is implemented for two conditions. First, if the AVR does not receive a response from OMAP/K32H within eight seconds after power-up, then the AVR disables the 5 V regulator. Second, when the user presses the power button, a 250 ms counter is started. If OMAP/K32H does not reset the countdown or cancel the countdown before the 250 ms has expired, then the AVR disables the 5 V regulator. Second, when the user presses the power button, a 250 ms counter is started. If OMAP/K32H does not reset the countdown or cancel the countdown before the 250 ms has expired, then the AVR disables the 5 V regulator. Within the O3 Control Head main board, A+ is used by the LCD display module where the A+ is regulated by a 12 V regulator and this is then supplied to the LCD backlight driver as the voltage input. If the vehicle's Ignition sense (ACC) is to be used as a means to sense power-on or power-off, then the CPS software tool can be used to enable ignition sensing and control a variety of customer power configurations.

The O9 control head is powered from vehicle's nominal 13.8 V (A+) battery. The control head's power distribution consists of switching voltage regulators and linear regulators sourced from the A+. The regulators provide voltages consisting of 5 V, 11 V, 9.6 V, 3.3 V, 2.5 V, 1.8 V, 1.5 V for operations of the circuitries on the board. An unswitched 3.3 V regulator is used to support basic circuitry while the radio is in the "off" state. A power management IC TPS65012 regulates almost most of the digital circuit components on the board with its 3.3 V switching regulator and OMAP's core voltage through the 1.5 V switching regulator. Additional linear regulator from this IC for 2.5 V and 1.8 V supports some required voltages on the Keypad encoder and SDRAM/OMAP respectively. The TPS65012 performs reset timing and voltage ramping as required by the OMAP processor as this function is built in the power management IC. Linear regulators of 11 V and 9.6 V are used for biasing circuit of audio amplifier circuit. The power is turned on by pressing the on or off button. The output ON_OFF switches state from low to high. This triggers the AVR to initiate power on, eventually pulling the 5V_Enable pin low and enabling output from the 5 V switched regulator. Supply from the 5 V switched regulator enables the TPS65012 power management IC and the power sequencing within the IC starts to turn on

1.5 V as the first supply to OMAP core. Upon reaching the threshold, other voltage outputs would be turned on and finally release the Reset pin of OMAP.

CAN3 output controlled by AVR sends command through the CAN transceiver to turn on.

The O2 and O7 remote control head is powered from vehicle nominal 13.8 V (A+) battery. The control head power distribution consists of switching voltage regulators and linear regulators sourced from the A+. The regulators provide voltages consisting of 5 V, 3.3 V, 2.8 V, 1.8 V, and 1.4 V for the operations of the circuitries on the board. An unswitched 3.3 V regulator is used to support AVR circuit and CAN Transceivers. A switched 5 V switching regulator is used to supply power to USB and power management IC. A power management IC LM26480 regulates most of the digital circuit components on the board with its 1.8 V switching regulator and OMAP's core voltage through 1.4 V switching regulator. Additional linear regulator from this IC for 2.8 V and 1.8 V supports some required voltages on the I/O voltage, GCAI, USB HUB, Bluetooth, OMAP 5912 I/O voltage, and User interface LCD. The LM26480 performs reset timing and voltage ramping as required by the OMAP processor as this function is built in the power management IC. Linear regulators of 11 V and 9.6 V are used for biasing circuit of audio amplifier circuit. The power is turned on by pressing the on or off button. The output ON_OFF switches state from low to high. This triggers the AVR to initiate power on, eventually pulling the 5V_En pin low and enabling output from the 5 V switched regulator. Supply from the 5 V switched regulator enables the LM26480 power management IC and the power sequencing within the IC starts to turn on 1.4 V as the first supply to OMAP core. Upon reaching the threshold, other voltage outputs would be turned on and finally release the Reset pin of OMAP.

3.4.6
SPI Controller

The SPI Controller has the responsibility for interfacing to the system SPI bus to provide a control and status register interface for the FPGA.

The SPI is provided by the OMAP/K32H Microcontroller and this is done during system power up. Only then the FPGA behaves as a SSI-CAN-SSI Controller.

3.4.7
Flash IC

The FLASH memory is used to store the control head firmware.

The codeplug setting for ignition is stored in the control head FLASH. The FLASH is updated after communications is established with the transceiver. After the ignition setting has been changed in the codeplug using CPS, the radio should be turned on with the control head so that the control head FLASH is updated. Otherwise, the FLASH updates in the field on the first successful power-up sequence.

3.4.8
SDRAM IC

SDRAM is volatile memory used by the processor to perform normal operations. SDRAM is not field upgradeable.

3.4.9
Color Liquid Crystal Display (LCD) module for O3

The LCD module contains a 130x130 dot matrix LCD display and backlight LED. The LCD module uses two voltages, A+ and 2.8 V.

The display module is driven by an LCD controller internal to OMAP. The display interface consists of eight data lines, D0-D7, and three clock or synchronization lines. The control head firmware divides the display into four sections. The software menu button labels are displayed at the bottom. The next row

up is the primary text area, the third row up is the secondary text area, and the icon area is at the top of the display. The maximum primary text area character is 12x18 pixels and 10x15 pixels for secondary and tertiary text area.

3.4.10
Bi-Color Backlit BW Liquid Crystal Display (LCD) module for O5

The LCD module contains a 320x83 dot matrix LCD display (whereby the contrast is internally temperature compensated and is not user adjustable), backlight LED, and indicator LED.

The indicator LED have shutters that cover the LED when not in use. This prevents external light from reflecting off the LED, giving the user the false impression that the LED is active. The LCD module uses two voltages, SW_B+ and 2.8V. The display module is driven by an LCD controller internal to OMAP. The display interface consists of eight data lines, D0-D7, and three clock or synchronization lines.

The control head firmware divides the display into four sections. The software menu button labels are displayed at the bottom. The next row up is the primary text area., the third row up is the secondary text area, and icon area is at the top of the display. Both the primary and secondary text area can display 14 characters.

3.4.11
TFT Liquid Crystal Display (LCD) module for O9

The O9 supports a 4.3” TFT Liquid Crystal Display (LCD). It has a 480 x 272 RGB resolution and is capable of up to 16.7 M colors display.

It incorporates a trans-missive and micro-reflective lighting. It is also equipped with a LED driven backlight. The LCD uses a 24-bit RGB digital interface. An external LCD controller is used to drive the LCD panel due to the frame buffer limitations on the OMAP’s internal LCD controller. The EPSON S1D13742 LCD Controller is used as it has the capability to refresh the LCD panel independently, without overloading OMAP’s data bus. It is capable of driving the LCD panel with resolutions of up to 800 x 480 pixels.

The S1D13742 is a color LCD graphics controller with an embedded 768 K byte display buffer. This chip interfaces with OMAP through Specially-Optimized Screen Interface (SoSSI).

3.4.12
TFT Liquid Crystal Display (LCD) module for O2 and O7

The O2 and O7 supports a 2.6” TFT Liquid Crystal Display (LCD). It has a 320 x 144 RGB resolution display and is capable of displaying up to 262 k colors.

It is a transmissive LCD panel. The display module interface directly with OMAP through a Specially-Optimized Screen Interface (SOSSI).

3.4.13
TFT Liquid Crystal Display (LCD) module for E5

The E5 supports a 3.3” TFT Liquid Crystal Display (LCD). It has a 480x160 RGB resolution display and is capable of displaying up to 262k colors.

It is a transmissive LCD panel. The display module interface directly with K32H via a Flex IO.

3.4.14
O3 Remote Mount

The O3 control head can be remote mounted with both the APX mid-power and high-power transceivers.

In remote mount configuration, the 10 foot coiled CAN cable on the O3 CH connects to a 17 foot CAN straight cable, which attaches to the TIB.

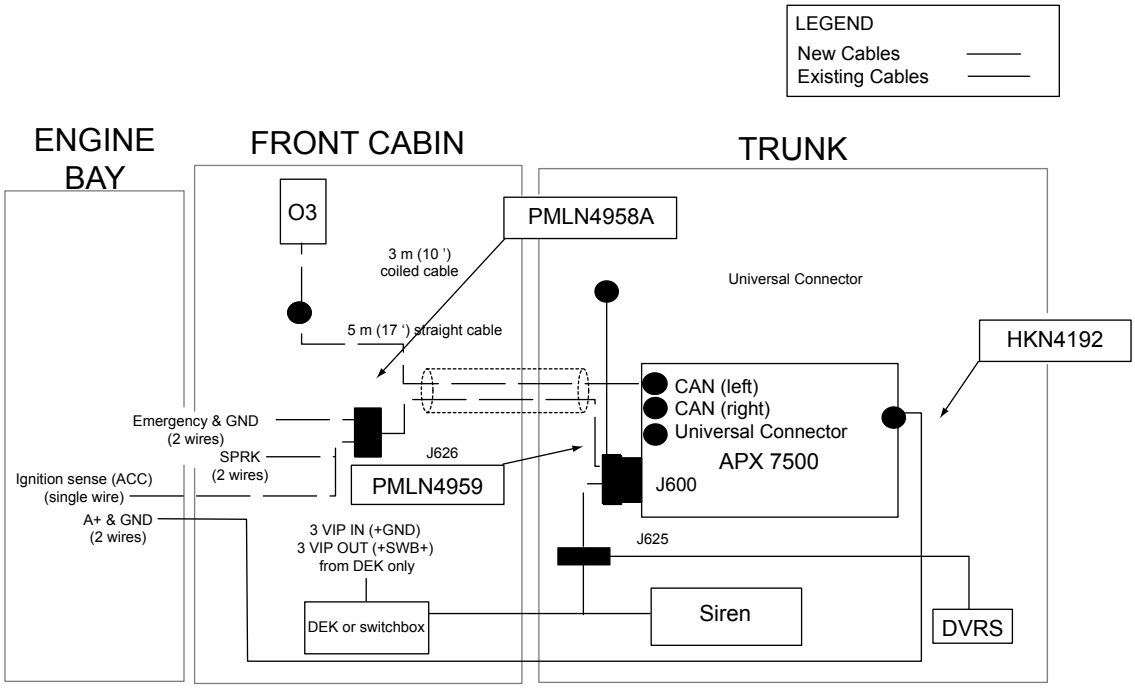
- Siren is supported.
- DEK is supported (only if Siren is installed).
- VIP In and Out's is supported through the DEK (only if both Siren and DEK are installed).
- DVRS is supported.

Digital vehicular repeater system (DVRS) connection is done through the J600 connector on the TIB using RS232 communication.

Programming capability is available on the trunk mounted transceiver through the MMP connector (J700).

Speaker, Emergency Footswitch, Ignition sense (ACC), and Audio Recording is routed through the J600 connector at the front of both the mid-power and high power transceivers.

Figure 23: O3 Remote Mount Configuration



3.4.15
O2 and O7 Remote Mount

The O2 and O7 control head can be remote mounted with both the APX mid-power and high-power transceivers.

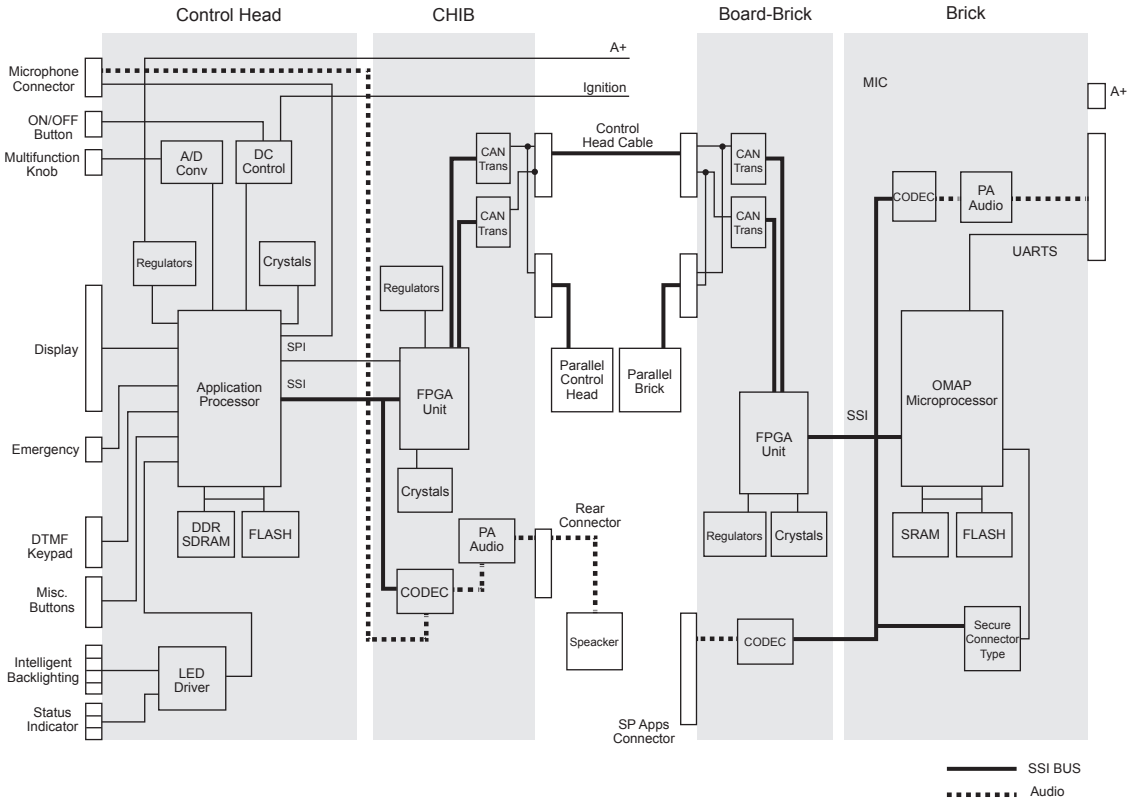
The O2 and O7 control head remote consists of a control head main board and CHIB. The control head is connected to the brick using a CAN cable.

A+ and ignition to the control head is connected through the control head power cables, and A+ to the bricks is connected through the bricks power cable.

Programming capability is available on the trunk mounted transceiver through the MMP connector (J700).

The speaker is connected through the rear connector on control head.

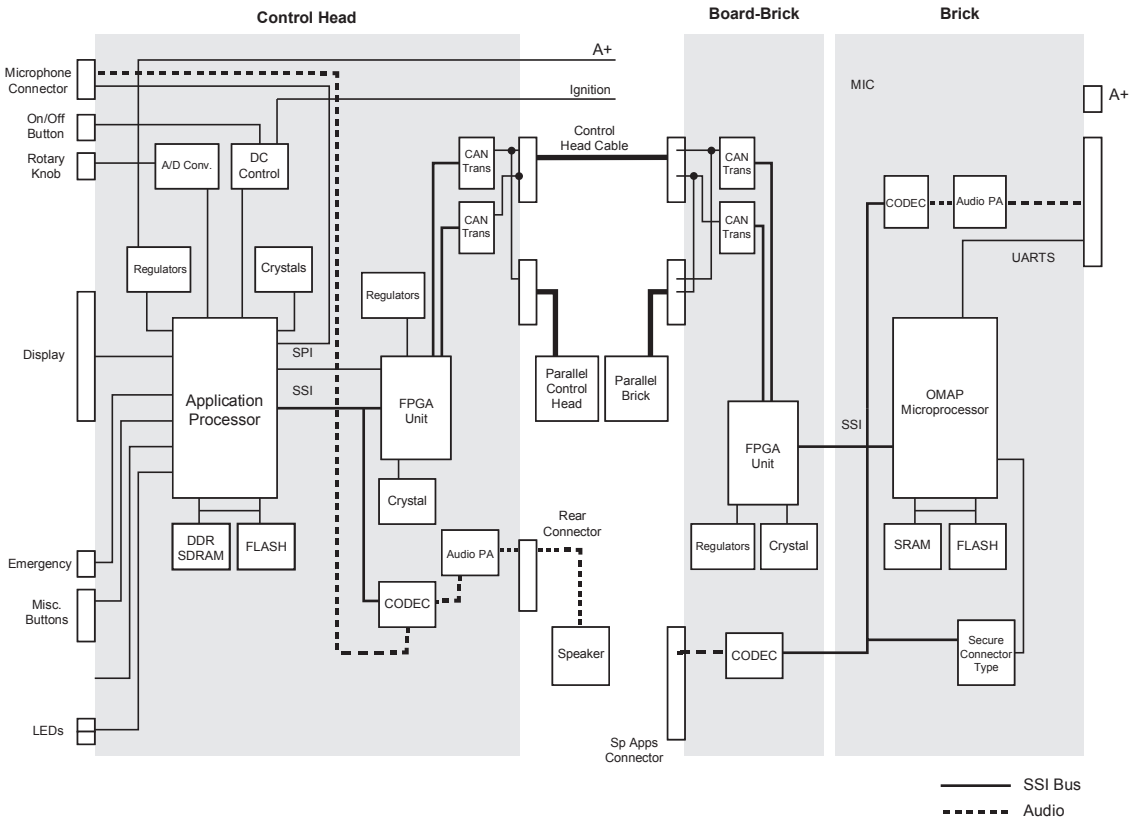
Figure 24: O2 and O7 Remote Mount Configuration



3.4.16

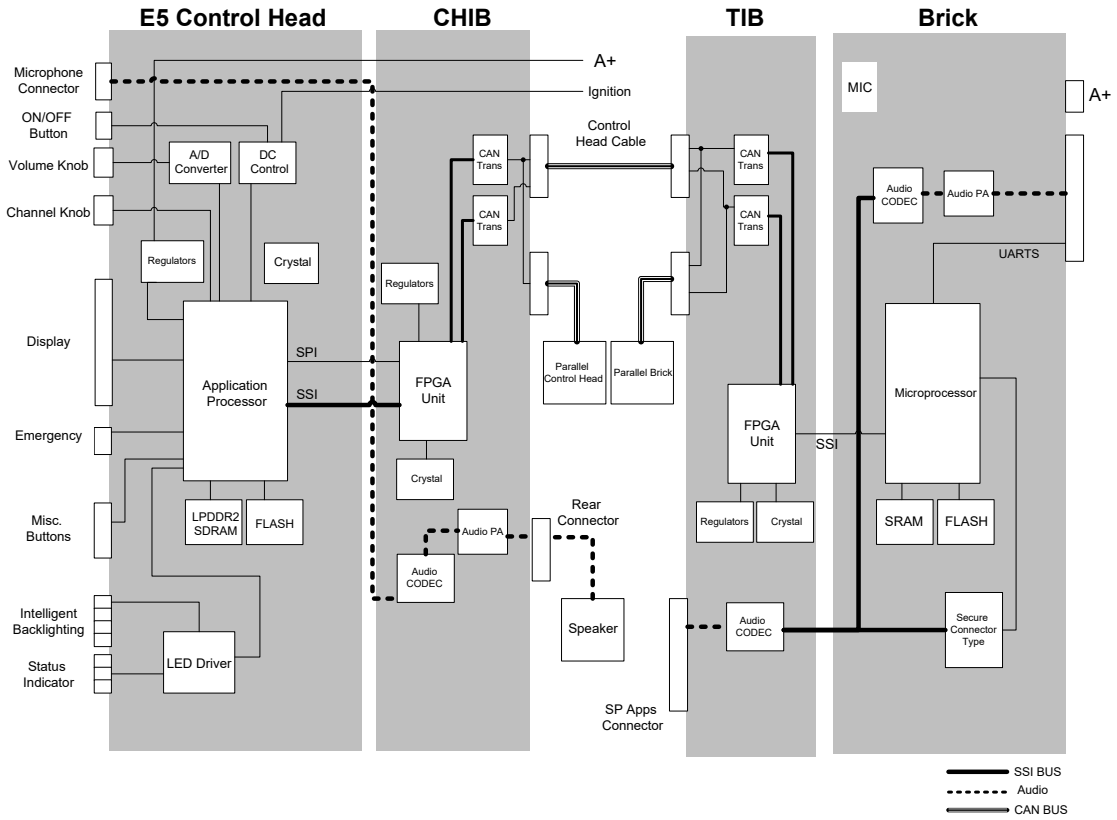
O9 and Transceiver Interface

Figure 25: O9 and Transceiver Interface Block Diagram



3.4.17
E5 and Transceiver Interface

Figure 26: E5 and Transceiver Interface Block Diagram



3.4.18
Vehicle Interface Port (VIP)

The VIPs allow the control head to operate external circuits and to receive inputs from external circuits.

3.4.18.1
O2/O3/O5/E5/O7/O9 Remote-Mount

There are three VIP outputs and three VIP inputs that are located on the back of the control head in connector J400 (only for O2, O5, E5, O7, and O9) and on the transceiver interface board (TIB) in connector J600.

The three VIP outputs in the J400 connector are implemented as open-drain MOSFETS capable of sinking 500 mA. Most applications use a relay connected between SW_B+ and the VIP output. Typical applications for VIP outputs are external horn/lights, alarm, and horn-ring transfer. Specifically for O9, it is capable of controlling the shot gun locks. Shorting SW_B+ directly to any of the VIP output lines without the use of a current limiting load damages the MOSFETS. If the load is a relay, then a back-EMF protection diode is required. These are commonly known in the field as a snubber diode. Refer to the installation manual for a graphical description.

The three VIP inputs in the J400 connector are internally pulled high. An external accessory pulls the VIP input to ground to trigger a VIP input. Each VIP input transistor is connected to a dedicated input port and buffered for input protection. VIP functionality is field programmable using CPS. See

installation manual HLN6923 for more information on VIP features, wiring, and operation. On the TIB, there are two VIP outputs present at J600. One is a dedicated VIP output but the second must be configured as a VIP output by changing a jumper. There are also two VIP inputs present at J600, but these are also only available by changing a jumper on the TIB.

Figure 27: Single O3 Control Head + VIPS

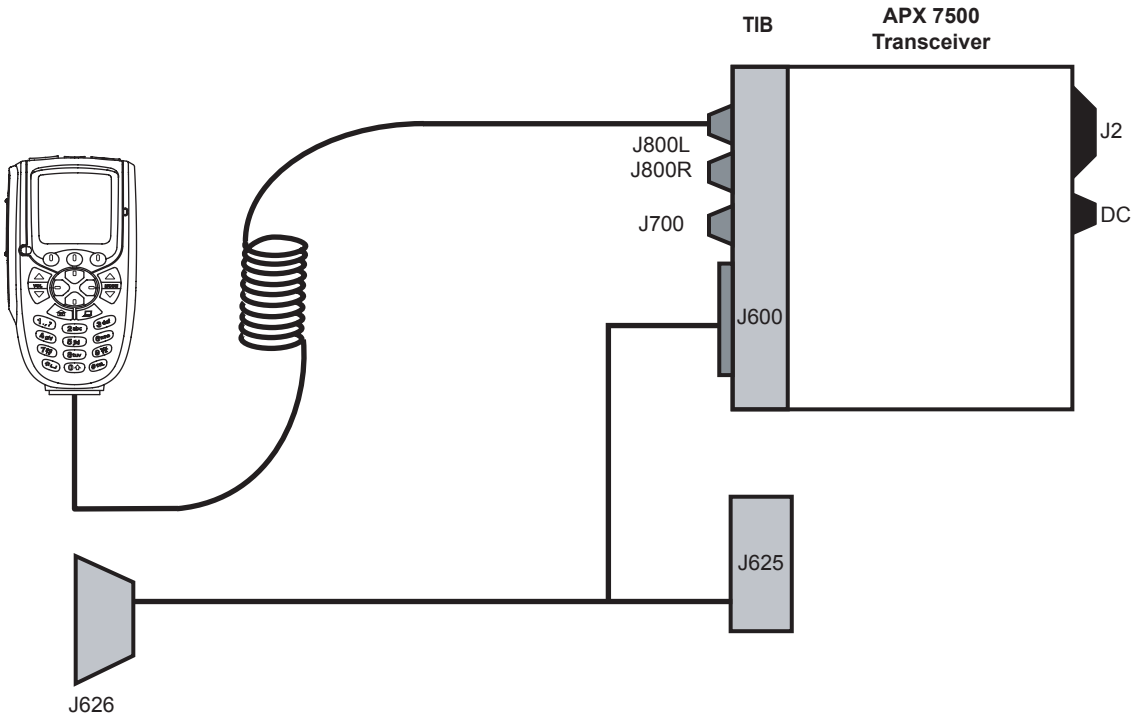
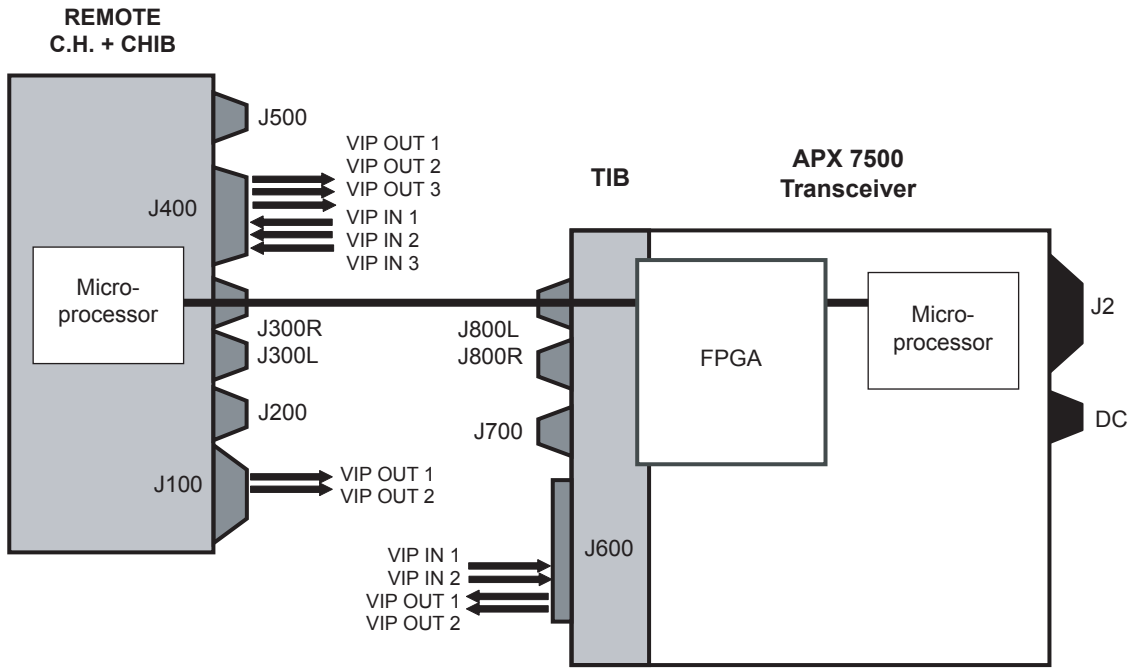
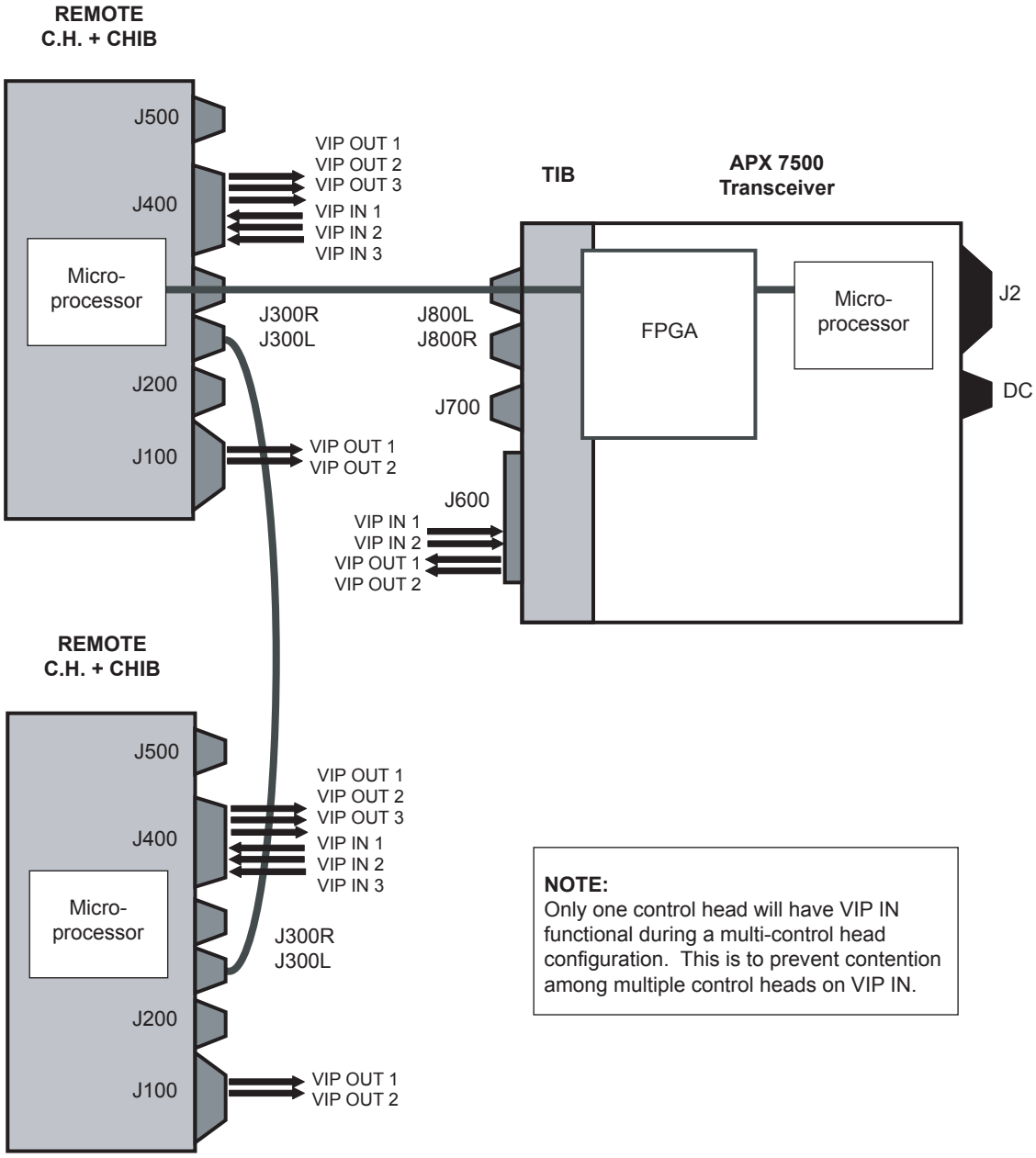


Figure 28: Single O2, O5, O7, O9 and E5 Control Head + VIPS



NOTE: J500 is not available for E5 CHIB.

Figure 29: Multiple O5/E5 Control Heads + VIPS



3.4.18.2

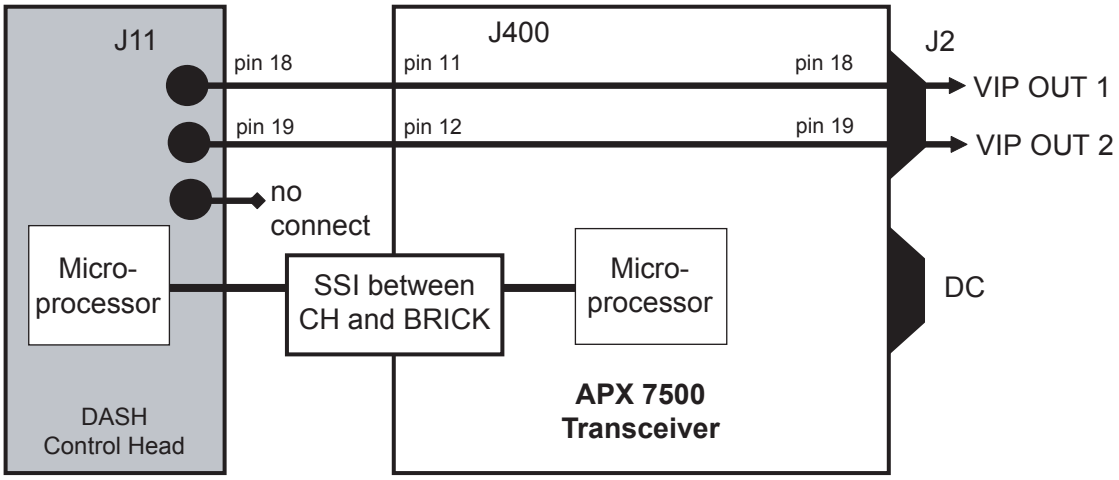
O5 Dash-Mount (Mid Power Only)

Two VIP outputs are available in the dash-mount configuration. These outputs are driven by open drain MOSFETS on the control head.

The VIP outputs pass through the transceiver to rear connector J2. Primarily, these transistors control external relays. The relay is connected between the VIP output and switched B+. Refer to the Remote-Mount section for duplicate information on VIP drive strength and warnings.

No VIP inputs are available in the dash-mount configuration.

Figure 30: Single Control Head + VIPS



3.4.18.3

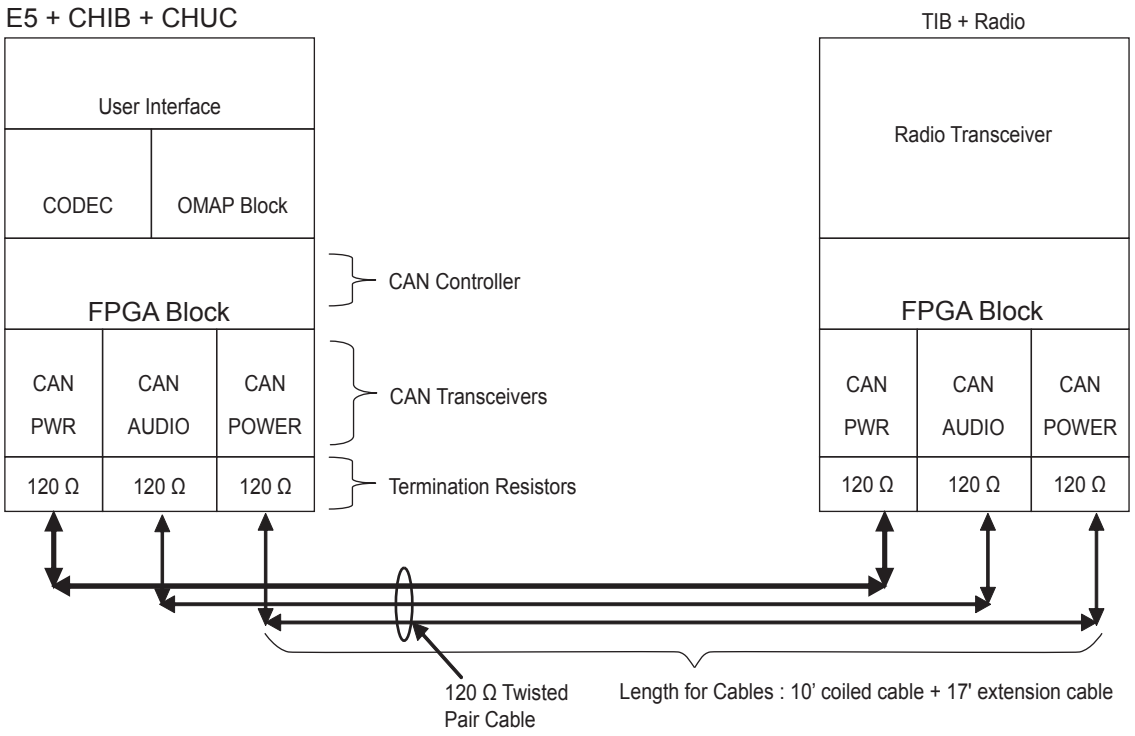
E5 Dash-Mount (Mid Power Only)

Two VIP outputs are available in the dash-mount configuration. These outputs are driven by open drain MOSFETS on the control head.

The VIP outputs pass through the transceiver to rear connector J2. Primarily, these transistors control external relays. The relay is connected between the VIP output and switched B+. Refer to the Remote-Mount section for duplicate information on VIP drive strength and warnings.

No VIP inputs are available in the dash-mount configuration.

Figure 31: CAN Termination Section.



NOTE: For E5, the OMAP block is replaced with K32H block.

3.4.19
Data Entry Keyboard (DEK)

In the remote-mount configuration, the DEK box allows the programming of a single button to perform a function that was selected in the CPS, when the radio was configured.

The DEK box is typically used for SIREN, to allow different modes or audio siren from being selected by the push of a button. Another use of the DEK box is the availability of 3 dedicated VIP-IN's and 3 dedicated VIP-OUT's. For a single DEK and control head configuration, Relays can be attached to the VIP pins to either allow your radio to toggle the relay through VIP-OUT, or to allow the radio to detect a change in mode, such as with the VIP-INs. Once you begin to add multiple control heads and DEK boxes, the VIP-IN's are only allowed on the back of DEK on one control head. This control head must be the only "VIP In Selected" control head in the configuration. Control Heads ship "VIP In Selected." When dual control heads are connected, one must be front-panel programmed in software to de-select VIP-IN operation. If the software detects dual control heads with VIP IN selected, an error is reported.

NOTE:
The software cannot detect when VIP-INs are physically connected to a control head which has had its VIP-INs e-selected/disabled by front-panel programming. No warning appears if VIP-INs are physically attached at both control heads.

Dual control head is available in the future.

There is no limitation as to where to tap-off for VIP-INs whether it is the back of the DEKs found on the first CHIB, or the back of the DEKs found at the second CHIB, or others. However, all three VIP-INs must only tap-off at whichever location is chosen. In other words, all must be at only one location at a

single control head. VIP-OUTs may be present on any or all the control heads in the system. The VIPs interface to the DEK, which interfaces with the Control Head.

The Control Head is programmed within CPS to know the function of VIP 1,2,3 at DEK A; VIP 1,2,3 at DEK B; and VIP 1,2,3 at DEK C. Refer to the CPS help menu for complete descriptions of the features that are selectable for the DEK.

Figure 32: Single O3 Control Head + DEK + VIPS

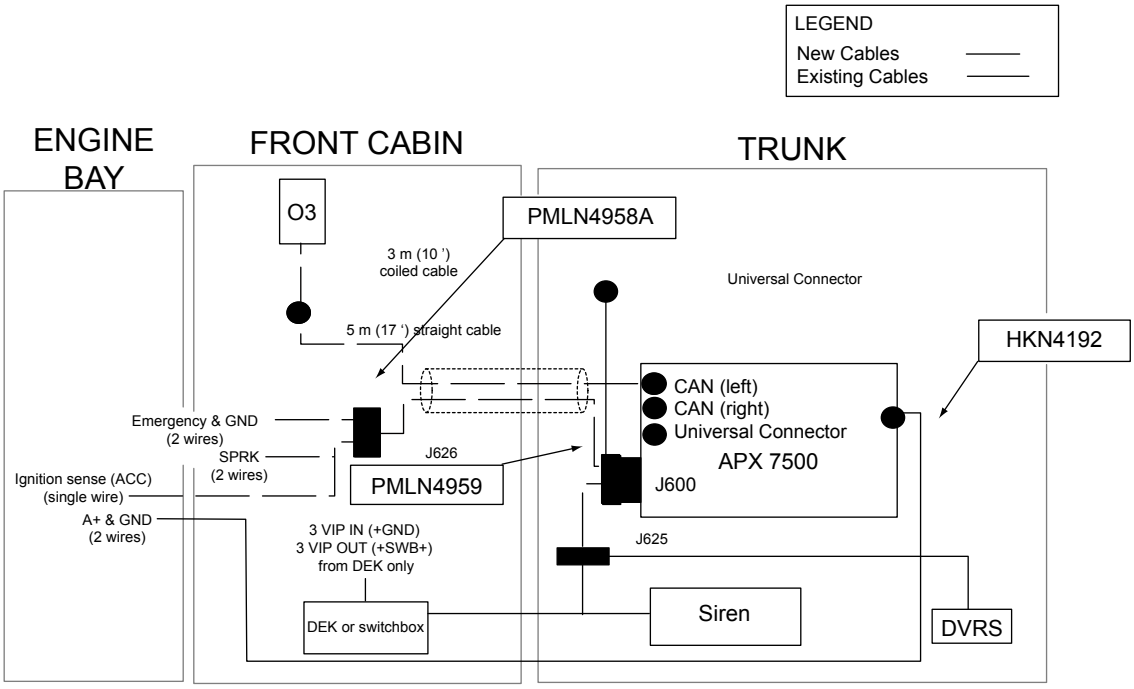


Figure 33: Single O5 Control Head + DEK + VIPS

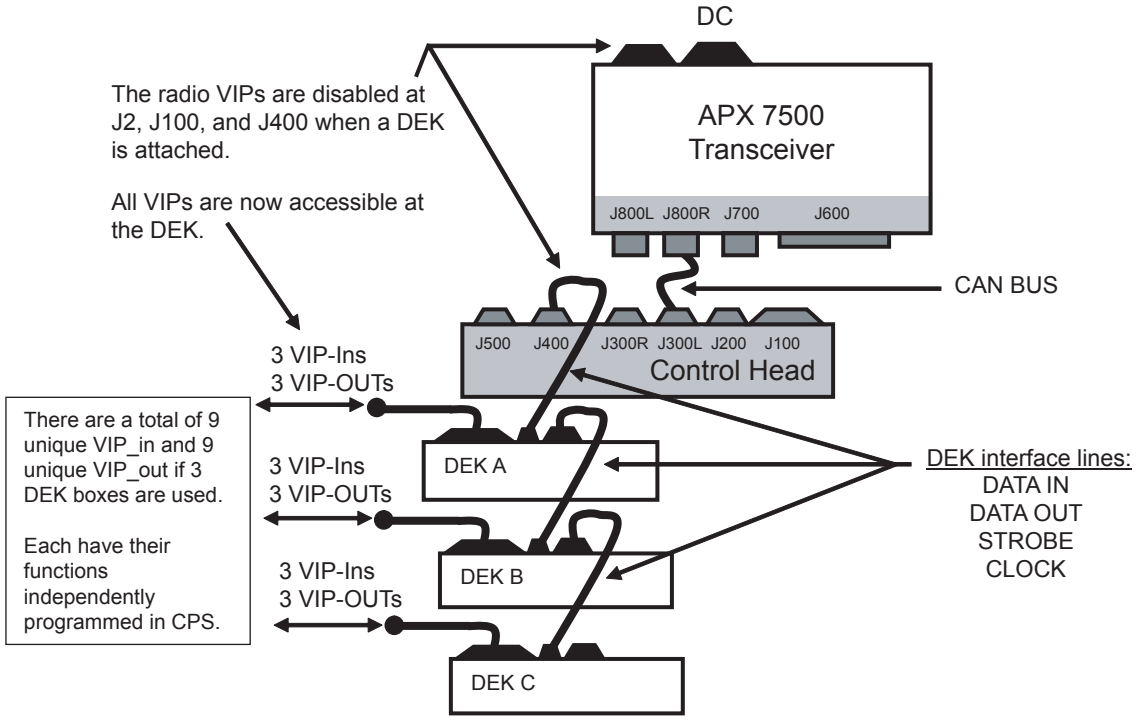
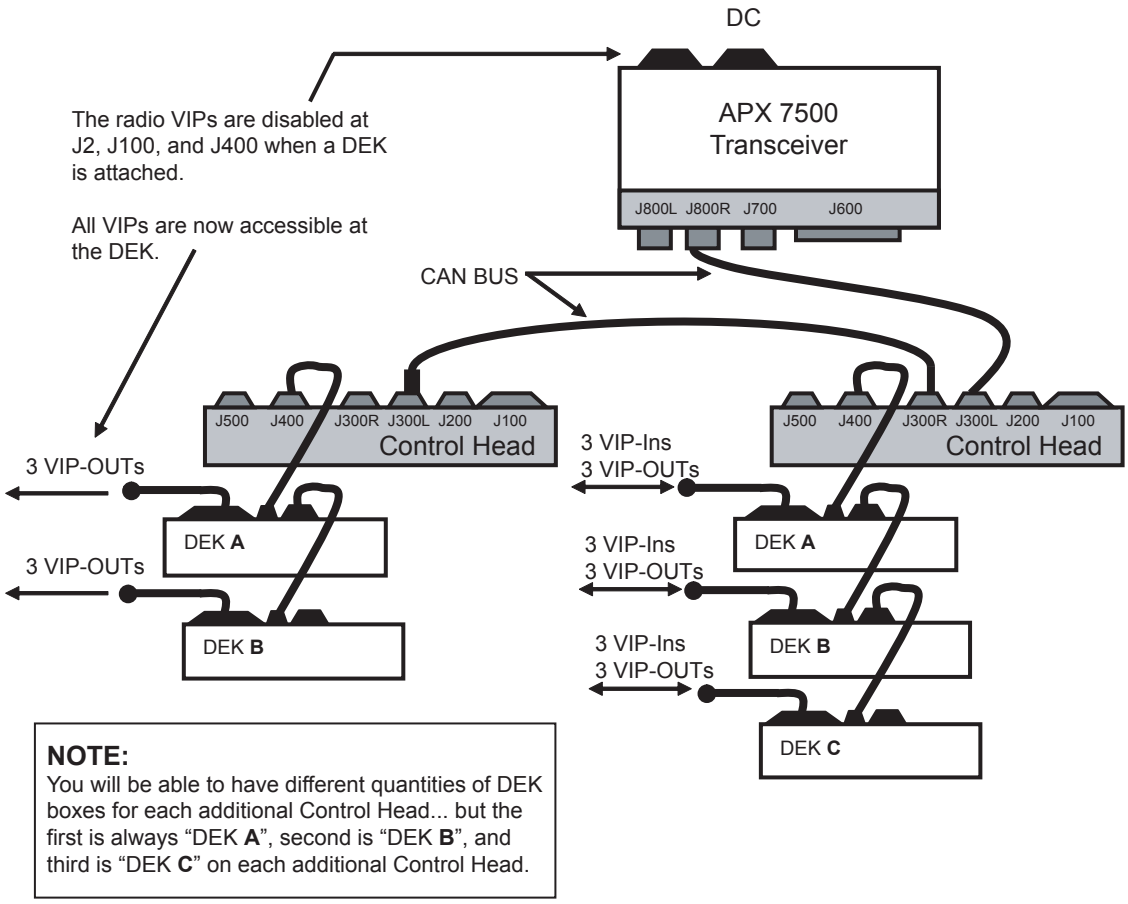

DC
The radio VIPs are disabled at J2, J100, and J400 when a DEK is attached.
All VIPs are now accessible at the DEK.
APX 7500 Transceiver
J800L J800R J700 J600
CAN BUS
J500 J400 J300R J300L J200 J100
Control Head
3 VIP-Ins
3 VIP-OUTs
There are a total of 9 unique VIP_in and 9 unique VIP_out if 3 DEK boxes are used.
Each have their functions independently programmed in CPS.
DEK A
DEK B
DEK C
DEK interface lines:
DATA IN
DATA OUT
STROBE
CLOCK

Figure 34: Multiple Control Heads + DEK +VIPS


DC
APX 7500
Transceiver
J800L J800R J700 J600
The radio VIPs are disabled at J2, J100, and J400 when a DEK is attached.
All VIPs are now accessible at the DEK.
CAN BUS
J500 J400 J300R J300L J200 J100
Control Head
J500 J400 J300R J300L J200 J100
Control Head
3 VIP-OUTs
3 VIP-OUTs
DEK A
DEK B
3 VIP-Ins
3 VIP-OUTs
3 VIP-Ins
3 VIP-OUTs
3 VIP-Ins
3 VIP-OUTs
DEK A
DEK B
DEK C
NOTE:
You will be able to have different quantities of DEK boxes for each additional Control Head... but the first is always “DEK A”, second is “DEK B”, and third is “DEK C” on each additional Control Head.

3.4.20

CAN Termination Section

Three CAN transceivers SN65HVD230 in the Control Head & TIB side are differentially paired to minimize on interference to the CAN Bus Network.

Each CAN transceiver is dedicated to transfer only one type of signal (Figure 36: CAN Termination Section. on page 100):

- CAN1 or CAN Audio – Transmit & receive audio signal from brick (Remote Mode).
- CAN2 or CAN Data – Interchange data & control between control head & brick in remote mode.
- CAN3 or CAN PWR – Send/Receive ON/OFF/RESET signal to/from the transceiver and control head.

The CAN architecture requires a termination resistor to be connected only at the two end-points of the CAN bus. The CAN cable contains a jumper that grounds a “detect pin” at the CAN connectors. Logic within the auto-termination circuit determines how many cables are attached and enables or disables the termination resistors, for each of the three twisted pairs. Figure 35: Two node system with CAN terminations enabled. on page 100 shows a system with terminations enabled on both the O5 control head and the radio transceiver. The O3 control head has the termination resistors enabled at

all times, since it is always an end-node. The radio+TIB and O5+CHIB could be daisy-chained, so the termination had to be toggled when not an end node.

NOTE: The remote mount cables are able to be connected to either the left CAN connector or to the right CAN connector. That is why they have the same connector number, with the letter L and R next to the connector to indicate Left or Right CAN connector. It is not recommended to have CAN cables attached but dangling free at one end, during operation.

Figure 35: Two node system with CAN terminations enabled.

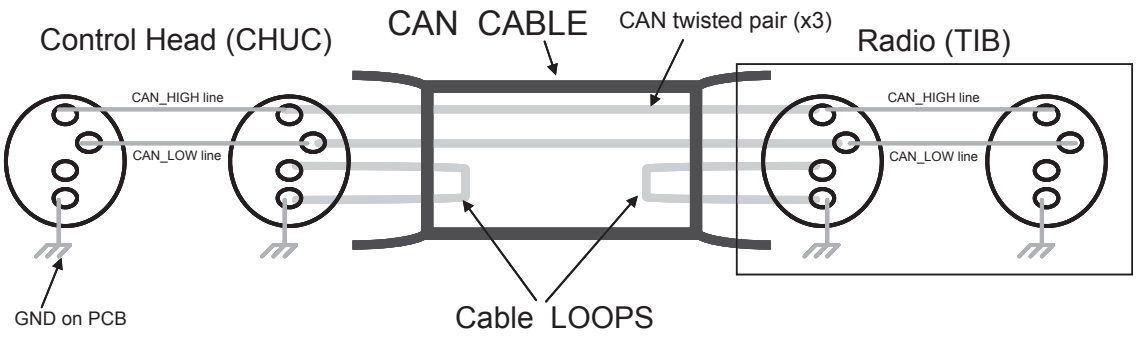
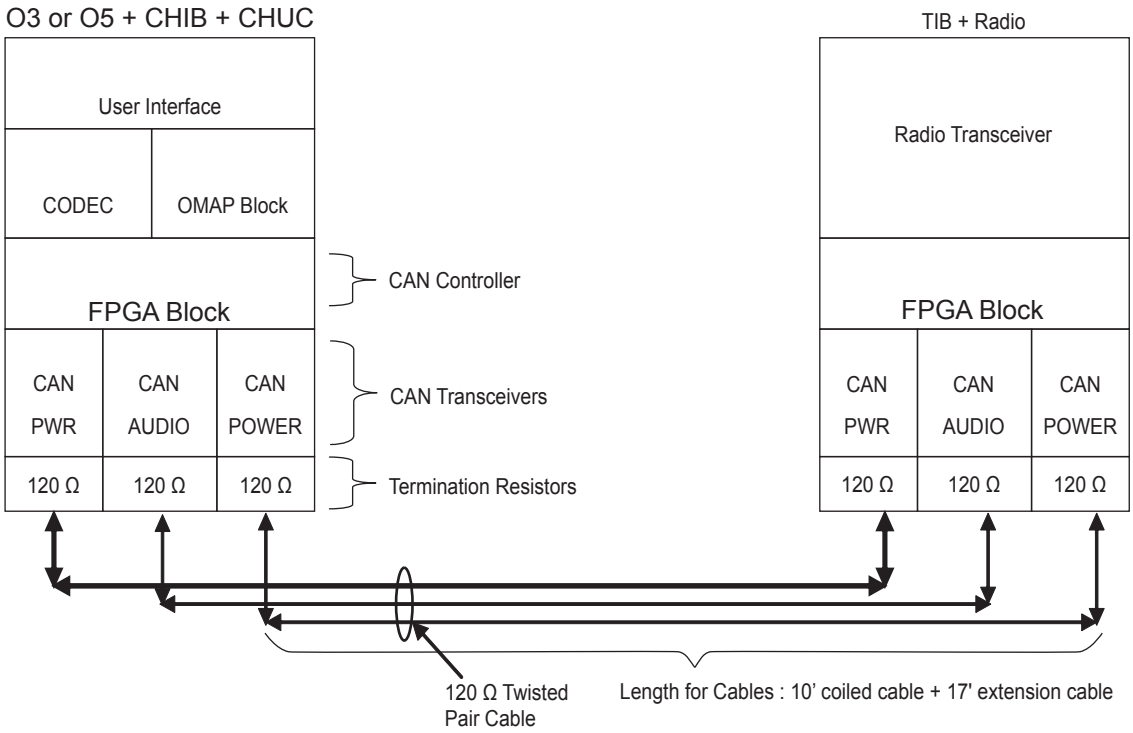


Figure 36: CAN Termination Section.



3.5 Control Head Interface Board (CHIB)

The Control Head Interface Board (CHIB) is used to provide functionality and connectivity between the Control Head Universal Connector (CHUC), the transceiver, and the Control Head.

For the remote-mount operation to function, the Synchronous Serial Interface (SSI) used to communicate between the control head and the transceiver in a Dash-mount configuration is converted on the CHIB to a Controller Area Network (CAN) protocol. The CHIB accomplishes this conversion using a Field-Programmable Gate Array (FPGA). This CAN data is then sent down the remote cable

from the CHIB, through the CHUC, into the Transceiver Interface Board (TIB), and finally into the transceiver. The CHIB also provides an audio power amplifier for driving a speaker, a USB host, a USB device transceiver, and an auto-termination circuit to terminate the CAN bus.

Table 26: Control Head and CHIB Compatibility

CHIB Kit Numbers	Compatible with Control Head
PHCN4003A	E5 Control Head
PMUN1057_	O2 and O7 Control Heads
PHCN4003E or greater	E5, O2, and O7 Control Heads

NOTE: PMUN4003E and above are not a direct replacement for PHCN4003A and PMUN1057_. Only qualified service personnel can perform Control Head upgrade procedures to replace PHCN4003A or PMUN1057_ with PHCN4003E and above. Failure to perform Control Head upgrade procedures properly can cause incompatibility issues between the Control Head and CHIB. For more information, contact Motorola Solutions Service Center or Depot.

Figure 37: O5 Control Head Interface Board (CHIB)

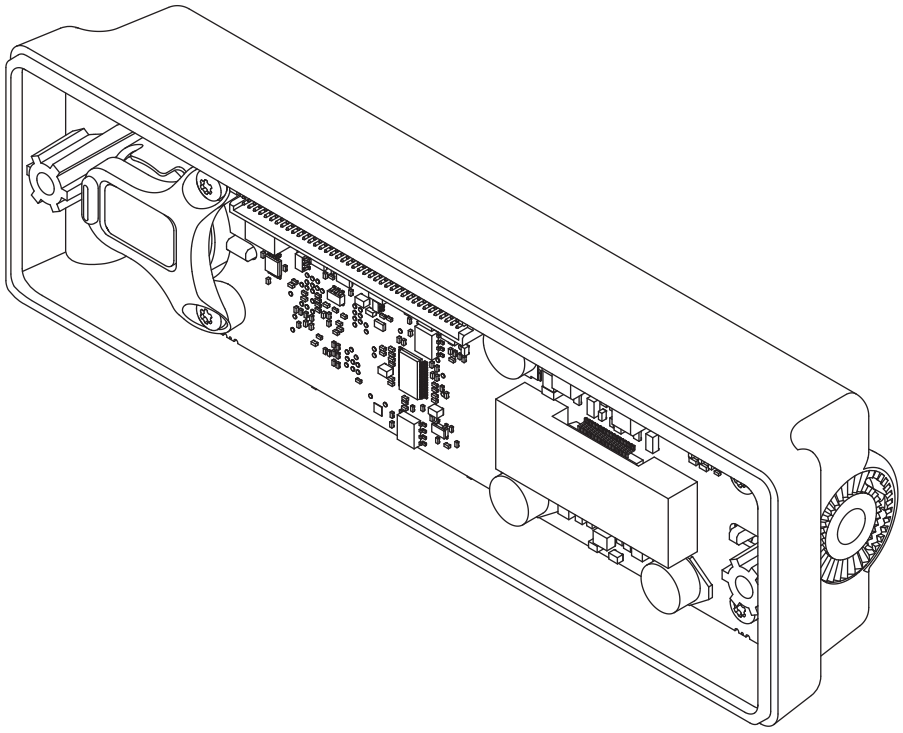


Figure 38: E5 Control Head Interface Board - CHIB

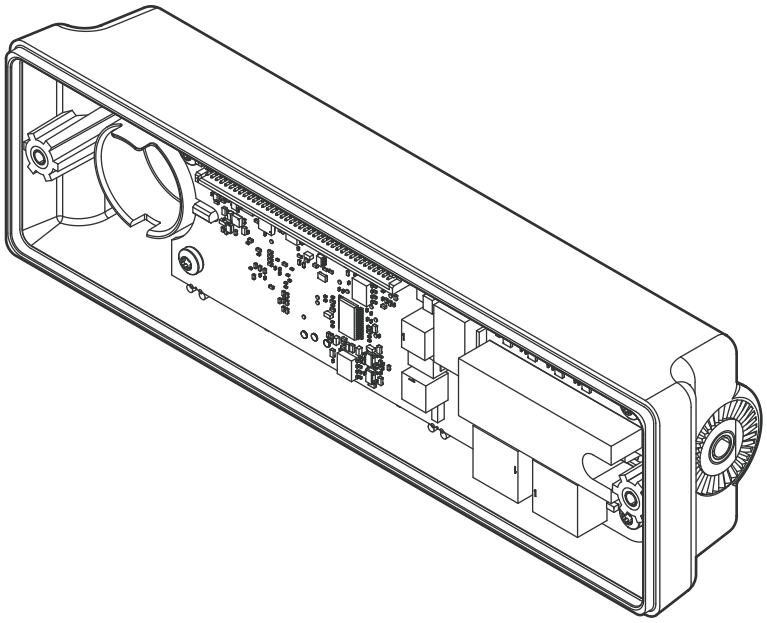
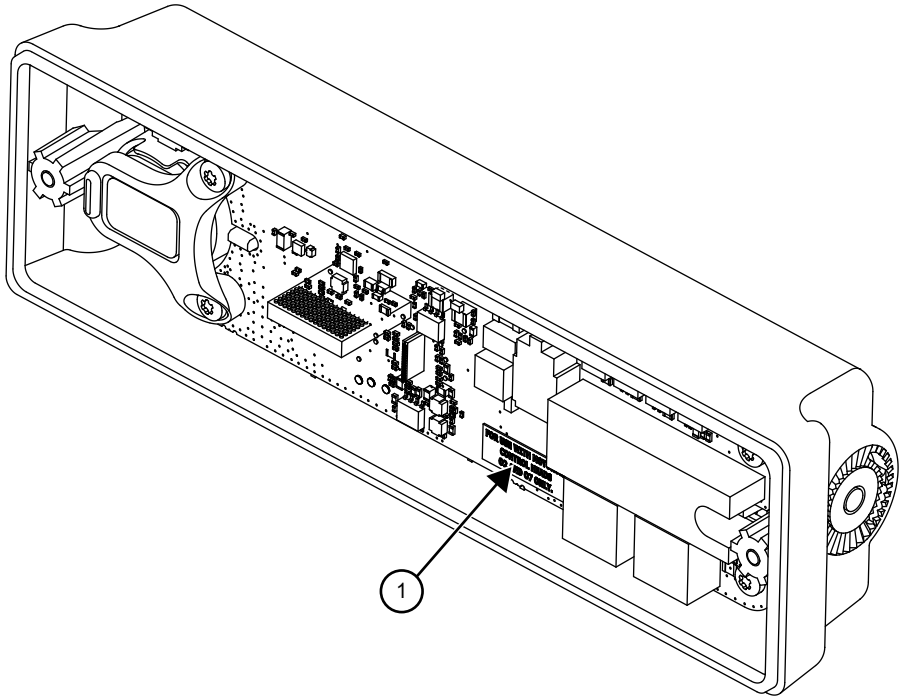


Figure 39: O2 and O7 Control Head Interface Board - CHIB



1	Motorola Solutions Label

NOTE: The O2 and O7 CHIB can be differentiated from O5 CHIB by the label “FOR USE WITH O2 and O7 MOTOROLA CONTROL HEADS ONLY.

3.5.1
FPGA Section

Refer to Field-Programmable Gate Array (FPGA) on page 85.

3.5.2
Audio Section

The audio section is comprised of a class D audio amplifier with associated feedback circuitry and output filters, a code/decode (CODEC) IC, and a programmable attenuator.

A voltage translator (U3007) is added between the FPGA and the CODEC from the CHIB because the supply voltage needed by the FPGA is 3.3 V and CODEC is 2.85 V, respectively. In receive mode, receive audio is sent to the FPGA through CAN. The FPGA converts the signal to SSI and routes the signal to the CODEC. The CODEC converts the signal to analog. Three analog CODEC outputs are used. Two are used for record out and ear jack out. These levels are fixed, meaning the volume control does not affect the output level. The third CODEC output is routed through a programmable attenuator, then into an A/D conversion stage and on to the class D audio amplifier. The differential output is short circuit protected and is capable of driving loads down to 3.2 ohms. Acceptable Speaker loads are between 3 to 10 ohms total. Attenuate headphones as needed for impedance and power rating. In transmit mode, the analog signal from the microphone is routed through the control head to the CHIB. A microphone can also be connected to the AUX_MIC input in the 26-pin accessory connector. These signals are feed into the CODEC, which selects the correct input, based on commands from the main board, and converts the signal to SSI. The SSI signal is sent to the FPGA, which performs the SSI to CAN conversion and sends the signal to the transceiver. The microphone bias circuit for both the MMP MIC_HI line and the accessory connector AUX_MIC input are located on the CHIB.

3.5.3
Power Section

A+ is routed through the Control Head Universal Connector (CHUC) and CHIB to the control head. An over-voltage transorb and fuse are located on the CHIB that protects the control head and CHIB from over-voltage transients and, to a limited extent, reverse-voltage wiring.

A+ is routed to the control head 5 V regulator input. The 5 V output is then routed back to the CHIB and powers four voltage regulators. The four supply voltages are 1.5 V, 1.8 V, 2.85 V, and 3.3 V. For PHCN4003 rev E and onwards, the 5 V output is then routed back to the CHIB and powers five voltage regulators. The five supply voltages are 1.0 V, 1.8 V, 2.85 V, and 3.3 V. The CHIB also has one un-switched 3.3 V supply that is feed directly from A+. SW_B+ from the control head is used to drive two additional regulators: an 11 V regulator, which is used by the audio PA and a 9 V regulator used to supply bias voltage to the MIC_HI and AUX_MIC inputs.

3.5.4
Connectivity Section

The CHIB contains two USB transceivers. One is used for USB host and the other is for USB device.

The USB device connection is through J100, the 26-pin connector. The USB host connection is through J500, a 4-pin water-sealed connector. All other connectivity signals route from the control head, through the CHIB, and out through the connectors on the CHUC.

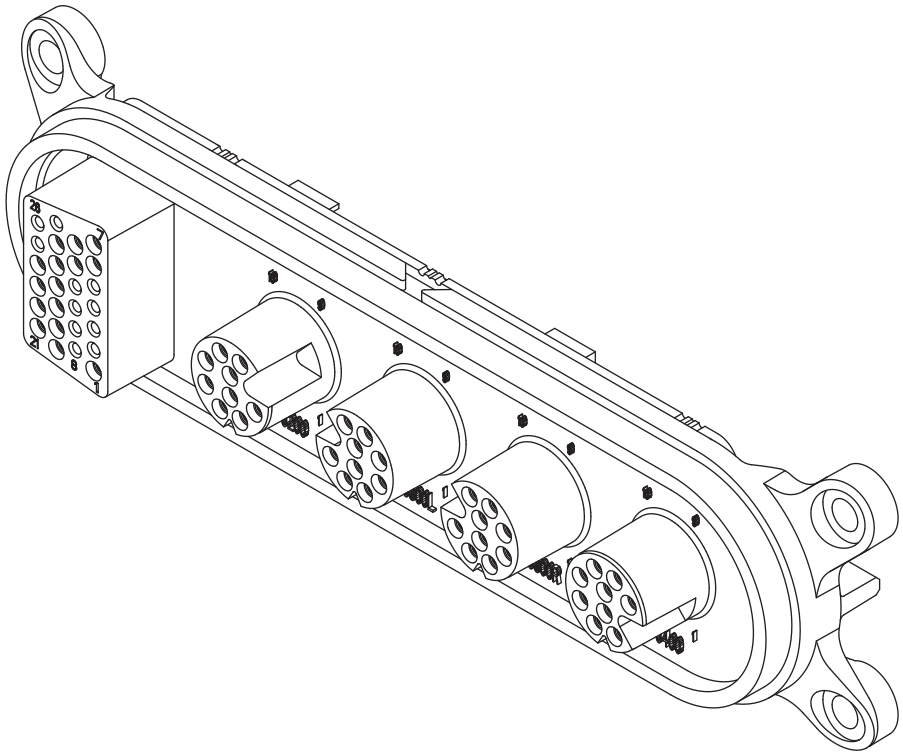
In the E5 CHIB, only one USB port is allocated to support E5 control head. The USB port can support both host or device mode depending on the accessory connected. The USB lines are routed from the K32H microcontroller to the J100 26 pin connector via the 80 pin connector. J500 is no longer present in the E5 CHIB.

3.6 O2/O5/E5/O7/O9 Control Head Universal Connector (CHUC)

The O2/O5/E5/O7/O9 Control Head Universal Connector (CHUC) is a separate board which provides multiple functions to the control head and CHIB.

Connectors J100, J200, J300, and J400 are all physically located on the CHUC, as well as the ESD protection for these pins. The signals from these connectors travel out through a 70-pin connector into the CHIB. The CHUC contains the switching circuitry that allows VIPS to exist at either J100 or J400, depending on cable detection. The voltage level shifting required for the duality of either DEK or VIP_IN / VIP_OUT at J400 is handled on the CHUC as well as a circuit to protect against reverse voltage wiring of the control head.

Figure 40: Control Head Universal Connector (CHUC)



3.7 O9 Universal Relay Controller Operation

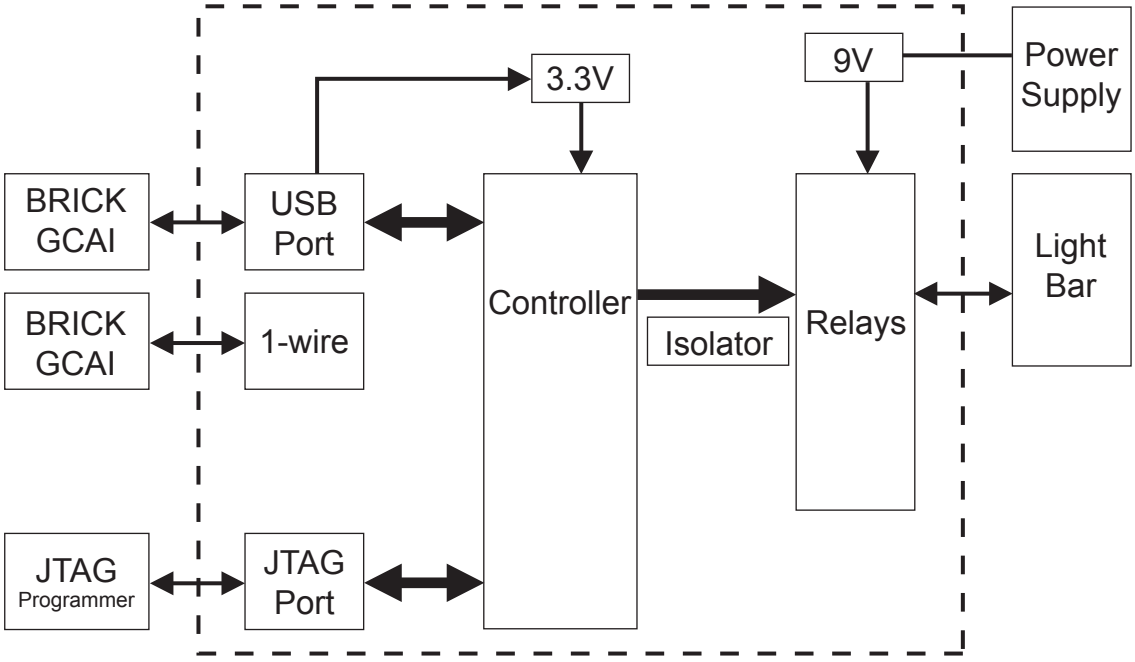
Universal Relay Controller (URC) is an extension of the O9 Control Head.

3.7.1 Universal Relay Controller Architecture

The Universal Relay Controller is an orderable accessory for O9 Control Head. It is used to control high power switching peripherals such as light bar.

URC works on all light bars which can be controlled by power application. The URC design consists of a 32-bit micro-controller. The URC is connected to the transceiver GCAI port. This URC uses 10 relays to control the switching device. A separate ground exists between the relay section and the MCU section, which is provided by the use of Analog Devices iCoupler. Each relay is connected to an output with 15 A fuse with the mains capable of connecting to two 60 A circuit breaker or fuses. One-wire EEPROM is employed to enable GCAI to recognize the Universal Relay Controller accessory ID. CPS can be used to program the relay patterns

Figure 41: HUB-Box Block Diagram



3.7.2
Controller Section

The controller used is from Atmel AT91 Thumb-based 32-bit ARM7DMI RISC Microcontroller series, the actual memory size and model to be specified when firmware is ready. The MCU features a USB Device Port v2.0 with full speed 12 Mbps compliant.

3.7.3
Power Management Section

During normal operation, this Universal Relay Controller is connected to O9 through TIB GCAI USB port.

The input power to this board is a direct supply from USB VBUS +5V. This is targeted to be less than 100 mA of current draw, that is total power consumption less than 500 mW. The MCU core voltage is 1.8 V+/-0.15 V, with the USB and GPIO voltage at 3.3 V+/-0.3 V, provided through the use of step down regulators.

3.7.4
Power Relays Section

10 relays from Tyco with ELV/RoHS/WEEE compliant is used for light bar control. Relays are capable for the rated fuse, 15 Amp, at 85 ℃ temperature.

The relays supply the power and control signal to the light bar. The relays should be used to flash/blink the lights directly. Their coils are charged up by a regulated 9 V supply to reduce heat generation from the relay coils.

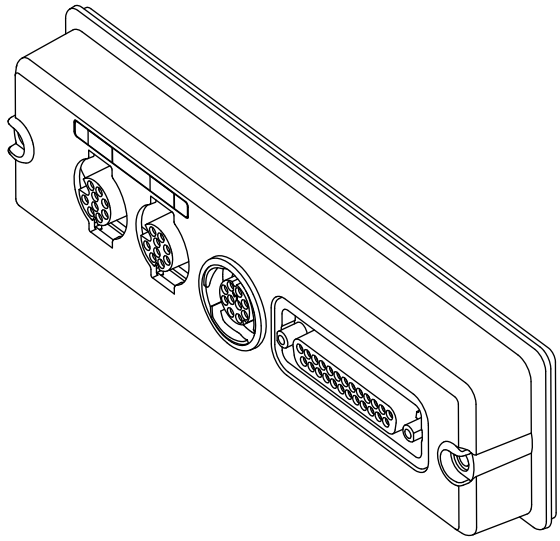
3.8 Transceiver Interface Board (TIB)

The Transceiver Interface Board (TIB) provides connectivity between the remote CAN cable and either the mid-power or high-power radio.

Opposite to that of the CHIB, the TIB must convert the CAN protocol back to Synchronous Serial Interface (SSI) through an FPGA, which is sent to the microprocessor. There also exists a legacy accessory interface J600, as well as the MMP J700 connection for data programming and secure key-loading of the radio. The TIB universal connector attaches directly to the board, so all ESD protection to the TIB circuitry and to the radio front connector is located throughout the TIB. Power-ON, Power-OFF, and RESET of the radio is accomplished using an ATMEL AVR microcontroller to toggle SWB+ as determined by commands from the Transceiver or from a remote device, such as a control head, connected to the CAN bus.

The TIB contains an audio CODEC which interfaces to the FPGA to route audio to accessories attached to the TIB and a control line back to the radio. A charge pump boost circuit is designed to allow RS232 functionality at the MMP when A+ is below nominal value. During normal operation, the boost circuit is disabled. The TIB is capable of using either RS232 or USB at its MMP connector. The TIB contains an identical auto-termination circuit to that used on the CHIB. Finally, the TIB contains the circuitry to drive relays through VIP_OUT paths and detect levels through VIP_IN paths.

Figure 42: Transceiver Interface Board (TIB)



3.8.1 Quick Disconnect Circuit

Quick disconnect circuit which is located in the TIB provides immediate muting of all speaker audio by forcing the radio to reset when a control head CAN cable is disconnected from the TIB or from an extension cable that is attached to the TIB.

After the disconnection, if there are no other control heads attached through CAN to the TIB, the radio may be programmed to automatically turn itself off (approximately 20 seconds after the radio reset). This programming is done through the CPS by check marking the **Control Head(s) Required for Power Up** field. The **Control Head(s) Required for Power Up** field is typically 'check marked' in a configuration that has a single O3 control which is attached to an extension cable that is attached to

the TIB. The radio immediately mute all speaker audio and ultimately power-off when the O3 control head is disconnected.

NOTE: If the **Control Head(s) Required for Power Up** field is NOT checked, the radio applies its normal power up rules such as ignition to determine whether to stay on or to power-off after the reset.

- If the field is 'check marked', then at least one control head must be present for the radio to remain powered-on after it resets. For example, if you only had one control head, and it is removed, the radio is powered-off after reset. If you had two control heads, and only one is removed, then after reset, the radio monitors the Ignition sense (ACC) line and compare to the ignition CPS setting to determine if it remains powered-on, or power-off. If you had two control heads, and you remove both, the radio is powered-off after reset.
- If the field is 'blank' (typical usage), then quick disconnect is not activated. For example, if you only had one control head, and it is removed, then after reset, the radio monitors the Ignition sense (ACC) line and compare to the ignition CPS setting to determine if it remains powered-on, or power-off. If you had two control heads, and only one is removed, the radio is powered-on after reset. If you had two control heads, and you remove both, the radio monitors the Ignition sense (ACC) line and compare to the ignition CPS setting to determine if it remains powered-on, or power-off.

3.9 Analog Mode of Operation

This section covers the receive and transmit operation.

3.9.1 Receive Operation

When the radio is receiving, the signal comes from the antenna through the RF PA output network located in the power amplifier section to the front-end receiver assembly. The signal is then filtered, amplified, and mixed with the first local oscillator signal generated by the receiver voltage controlled oscillator (VCO).

The resulting intermediate-frequency (IF) signal is fed to the IF circuitry where it is again filtered and amplified. This amplified signal is passed to the back-end receiver IC where it is mixed with the second local oscillator to create the second IF at 2.25 MHz. The analog IF is processed by an analog-to-digital (A/D) converter located within the digital back-end IC, where it is converted to a digital bit stream and decimated down to an I/Q digital sample. This digital signal is then passed on to the DSP, where filtering and discrimination are performed in the software. For a voice signal, the DSP routes the digital voice data to the Codec for volume gain control and conversion to an analog signal. The signal passes to the audio power amplifier, which drives the speaker. For signaling information, the DSP decodes the message and passes it to the microprocessor.

3.9.2 Transmit Operation

When the radio is transmitting, microphone audio is passed to the gain control circuit, and then to the Codec, where the signal is digitized. The Codec passes digital data to the DSP, where pre-emphasis and low-pass (splatter) filtering is done.

The DSP may also add signalling information. The DSP then sends the resulting digitized signal containing both voice and signalling data to the digital synthesizer IC as a modulation signal for the transmitter voltage controlled oscillator. A modulated carrier is provided to the RF power amplifier, which transmits the signal under dynamic power control.

3.10
ASTRO Mode of Operation

In the ASTRO mode (digital mode) of operation, the transmitted or received signal is limited to a discrete set of deviation levels, instead of continuously varying. The receiver handles an ASTRO-mode signal identically to an analog-mode signal up to the point where the DSP decodes the received data.

In the ASTRO receive mode, the DSP uses a specifically defined algorithm to recover information.

In the ASTRO transmit mode, microphone audio is processed the same as in the analog mode with the exception of the algorithm the DSP uses to encode the information. This algorithm results in deviation levels that are limited to discrete levels.

3.11
Radio Frequency Transceiver Board (RF Board)

3.11.1
Radio-Frequency Power Amplifier (RF PA) and Output Network (ON)

The RF PA is a three-stage power amplifier consisting of discrete LDMOS transistors.

The followings are the three stages:

- Controlled stage
- Driver stage
- Final stage

The RF PA is followed by the ON section, consisting of discrete circuitry with the following functions:

- Antenna switch
- Harmonic filter
- Power detector

3.11.2
Gain Stages

The controlled stage consists of two-stage, integrated amplifier with external matching, which amplifies the input signal from the VCO buffer and provides drive to the driver stage.

Power is controlled through gate bias to both internal stages, and drain bias is supplied through K9.1 V, through a band selector switch, but for APX 2500/4500/4500Li/1500 there is no band selector switch involved. The driver stage has a fixed gate bias. The driver drain bias is supplied by the A+ (battery) voltage in the VHF 100 W, UHF 100 W and 700–800 MHz radio. Driver stage drives the final stage, which consists of two transistors operating simultaneously, but only one transistor for VHF 50 W model. Both final devices have separate, fixed gate biases, and their final drain biases are supplied by the A+ voltage. The output of the final stage feeds the antenna switch, which routes the RF PA to the harmonic filter/power detector/antenna and isolates the RX front-end in transmit mode. Antenna switch routes antenna/power detector/harmonic filter to RX, and isolates TX in RX mode. Mode is determined via K9.1 V. The harmonic filter is a low-pass filter that attenuates harmonics generated by the RF PA in-transmit mode and provides additional receive selectivity in receive mode.

3.11.3
Power Control

The power control section regulates the RFPA output power by an automatic level control (ALC) circuit.

The transmitter ALC consists of a digital attenuator, voltage variable attenuator, RF log amp, digital-to-analog converter (DAC), and buffer or amplifier. The APX 2500/4500/4500Li/ 1500 has the similar transmitter ALC, but with addition of analog-to-digital converter (ADC). The power detector senses the incident power transferred to the antenna through a directional coupler in which the RF signal is fed to the digital attenuator, voltage variable attenuator and the RF log amp. The RF log amp compares the input RF power from the directional coupler with the voltage set from the DAC to generate a DC voltage. The DC voltage is then gained by the buffer or amplifier and fed to the RFPA stage. The radio carrier power level is set by adjusting the DAC voltage set while monitoring the output power, which is saved in the radio memory.

3.11.4
Circuit Protection

The RFPA driver and final stage drain current, RFPA final stage temperature, RFPA control voltage, and battery voltage are sensed by the power control circuitry.

If a fault condition is detected, the control voltage is reduced, which cuts back the output power to a level that is safe for the particular operation conditions.

3.11.5
DC Interconnect

The DC connector at the edge of the board carries the A+ supply for the entire board.

This supply is routed directly to the controller and transmitter circuitry for both direct supply and regulating additional supplies. The radio chassis is grounded through the PCB screws and also through direct contact to the board. The dash mount control head receives the A+ supply through the 50-pin flex connector.

3.12
VHF Receiver Overview

The primary duties of the receiver circuits are to detect, filter, amplify, and demodulate RF signals in the presence of strong interfering noise and unintended signals.

The receiver contains the following blocks:

- Front-end (preselectors and LNAs)
- Mixer
- IF
- Back-end

3.12.1
Receiver Front-End

The VHF receiver operates in the frequency range of 136 to 174 MHz.

The primary function of receiver front-end is to optimize the rejection of image frequency and other out-of-band frequencies, while providing low-noise amplification of received signal.

The front-end uses discrete fixed tuned filters, and discrete bipolar LNAs.

The front-end configuration supports the following modes:

Table 27: Front-End Configuration

Configuration	Description
Standard Mode	Provides the best intermodulation performance.
Optional Pre-Amp Mode	Provides improved sensitivity, but lower inter-modulation performance.

The front-end line-up for Standard Mode is consists of the following component:

- A switched 15 dB attenuator for AGC purposes
- A 4-pole Chebyshev bandpass filter
- A low-noise amplifier
- A 6-pole elliptic bandpass filter

The front-end line up for Optional Pre-Amp Mode is consists of the following component:

- 2-pole high pass filter
- Additional LNA is added between the attenuator and the first bandpass filter

3.12.2
Mixer

The receiver front-end signal is fed to the monolithic Mixer IC where it is down converted to an IF of 109.65 MHz.

The mixer is designed to provide low conversion loss and high inter-modulation performance. The mixer is driven by the receiver injection buffer, a two-stage discrete IC design used with the receiver VCO to efficiently drive the mixer over a wide temperature range with minimum power variation. The injection buffer provides 17 dBm to the mixer. The VCO provides high-side injection for the VHF band. The design maintains temperature stability, low insertion loss, and high out-of-band rejection.

3.12.3
IF Circuitry

The crystal filters provide IF selectivity and out-of-band signal protection to the back-end IC.

The two 2-pole crystal filters centered at 109.65 MHz are isolated from one another by a discrete IF amplifier.

This enables the receiver to meet gain specifications, close in intermodulation rejection, adjacent channel selectivity, and second-image rejection.

3.12.4
Receiver Back-End

The output of the IF circuit is fed directly to the back-end receiver IC. This uses a variable-bandwidth bandpass sigma-delta architecture.

It is capable of down-converting analog, as well as digital, RF protocols into a baseband signal, which is then transmitted over the Synchronous Serial Interface (SSI) bus. It also converts the 109.65 MHz signal from the IF section down to 2.25 MHz using a second LO frequency, which is produced by the second LO VCO. This VCO runs at 107.4 (low-side injection) or 111.9 MHz (high-side injection). The choice of frequency depends on known spurious interference related to the programmed received frequency.

3.13
UHF R1 & R2 Receiver Overview

The primary duties of the receiver circuits are to detect, filter, amplify, and demodulate RF signals in the presence of strong interfering noise and unintended signals.

The receiver contains the following blocks:

- Front-end (preselectors and LNAs)
- Mixer
- IF
- Back-end

3.13.1
Receiver Front-End

The UHF R1 receiver operates in the frequency range of 380 to 470 MHz. UHF R2 receiver operates in the frequency range of 450 to 520 MHz.

The primary function of the receiver front end is to optimize the rejection of the image frequency and other out-of-band frequencies. This provides low-noise amplification of the received signal. The front end uses varactor-tuned filters and discrete E-PHEMT LNAs. The front end has two possible configurations:

- Standard mode, which provides the best intermodulation performance; and
- Preamp mode (optional), which provides improved sensitivity at the cost of slightly reduced intermodulation performance.

The front-end lineups for standard mode are:

- - A switched 15 dB attenuator for AGC purposes.
  - Two pole high pass filters.
  - Two Varactor-tuned image filters.
  - Low-noise amplifier.

  In preamp mode, an additional E-PHEMT LNA is added between the attenuator and the first bandpass filter. This is using discrete PIN diode switches.

3.13.2
Mixer

The receiver front-end signal is fed to the monolithic Mixer IC. It also down converted to an IF of 109.65 MHz.

The mixer is designed to provide low conversion loss and high intermodulation performance. The mixer is driven by the FGU receiver injection buffer. This efficiently drives the mixer over a wide temperature range with minimum power variation. The injection buffer provides 17 dBm to the mixer. The design maintains temperature stability, low insertion loss, and high out-of-band rejection.

3.13.3
IF Circuitry

The crystal filters provide IF selectivity and out-of-band signal protection to the back-end IC.

The use of two 2-pole crystal filters centered at 109.65 MHz, which are isolated from one another by a discrete IF amplifier, is to:

- Enable the receiver to meet specifications for gain.

- Close-in inter-modulation rejection
- Adjacent channel selectivity
- Second-image rejection.

3.13.4
Receiver Back-End

The output of the IF circuit is fed directly to the back-end receiver IC. This uses a variable-bandwidth bandpass sigma-delta architecture. It is capable of down-converting analog, as well as digital, RF protocols into a baseband signal, which is then transmitted over the Synchronous Serial Interface (SSI) bus. It also converts the 109.65 MHz signal from the IF section down to 2.25 MHz using a second LO frequency, which is produced by the second LO VCO. This VCO runs at 107.4 (low-side injection) or 111.9 MHz (high-side injection). The choice of frequency depends on known spurious interference related to the programmed received frequency.

3.14
700–800 MHz Receiver Overview

The receiver circuits primary duties are to detect, filter, amplify, and demodulate RF signals in the presence of strong interfering noise and unintended signals.

The receiver is broken down into the following blocks:

- Front-end (preselector and LNA)
- Mixer
- IF
- Back-end

3.14.1
Receiver Front-End

The 700–800 MHz receiver front-end operates in two bands.

The primary function of the receiver front-end is to optimize image rejection and selectivity while providing the first conversion. The
front-end uses ceramic-filter technology and includes a wideband, monolithic amplifier.

The first filter is a dual-switched filter that reduces the image frequency response and limits some of the
out-of-band interference. The second filter following the monolithic Low Noise Amplifier (LNA) provides additional image rejection.

3.14.2
Mixer

The receiver front-end signal is fed to the monolithic Mixer IC where it is down converted to an IF of 109.65 MHz.

The mixer is designed to provide low conversion loss and high inter-modulation performance. The mixer is driven by the receiver injection buffer, a two-stage discrete IC design used with the receiver VCO to efficiently drive the mixer over a wide temperature range with minimum power variation. The injection buffer provides 17 dBm to the mixer. The VCO provides low-side injection to the 700–800 MHz bands. The design maintains temperature stability, low insertion loss, and high out-of-band rejection.

3.14.3
IF Circuitry

The crystal filters provide IF selectivity and out-of-band signal protection to the back-end IC.

Two 2-pole crystal filters centered at 109.65 MHz that are isolated from one another by a stable, is to:

- Use moderate-gain amplifier to meet the receiver specifications for gain.
- Close-in intermodulation rejection.
- Adjacent channel selectivity.
- Second-image rejection.

3.14.4
Receiver Back-End

The output of the IF circuit is fed directly to the back-end receiver IC.

This uses a variable-bandwidth bandpass sigma-delta architecture. It is capable of down-converting analog, as well as digital, RF protocols into a baseband signal, which is then transmitted over the Synchronous Serial Interface (SSI) bus. It also converts the 109.65 MHz signal from the IF section down to 2.25 MHz using a second LO frequency, which is produced by the second LO VCO. This VCO runs at 107.4 (low-side injection) or 111.9 MHz (high-side injection). The choice of frequency depends on known spurious interference related to the programmed received frequency.

3.15
900 MHz Receiver Overview

The receiver circuits primary duties are to detect, filter, amplify, and demodulate RF signals in the presence of strong interfering noise and unintended signals.

The receiver is broken down into the following blocks:

- Front-end (preselector and LNA)
- Mixer
- IF
- Back-end

3.15.1
Receiver Front-End

The 900 MHz receiver front-end operates in the frequency range of 935 to 941 MHz.

The primary function of the receiver front-end is to optimize image rejection and selectivity while providing the first conversion.

The front-end uses ceramic filter technology and includes a wideband, monolithic amplifier.

The first filter is a dual-switched filter that reduces the image frequency response and limits some of the out-of-band interference.

The second filter following the monolithic Low Noise Amplifier (LNA) provides extra image rejection.

3.15.2
Mixer

The receiver front-end signal is fed to the monolithic Mixer IC where it is down converted to an IF of 109.65 MHz.

The mixer is designed to provide low conversion loss and high inter-modulation performance. The mixer is driven by the receiver injection buffer, a two-stage discrete IC design used with the receiver VCO to efficiently drive the mixer over a wide temperature range with minimum power variation. The injection buffer provides 17 dBm to the mixer. The VCO provides low-side injection to the 900 MHz band. The design maintains temperature stability, low insertion loss, and high out-of-band rejection.

3.15.3
IF Circuitry

The crystal filters provide IF selectivity and out-of-band signal protection to the back-end IC.

Two 2-pole crystal filters centered at 109.65 MHz that are isolated from one another by a stable, is to:

- Use moderate-gain amplifier to meet the receiver specifications for gain.
- Close-in intermodulation rejection.
- Adjacent channel selectivity.
- Second-image rejection.

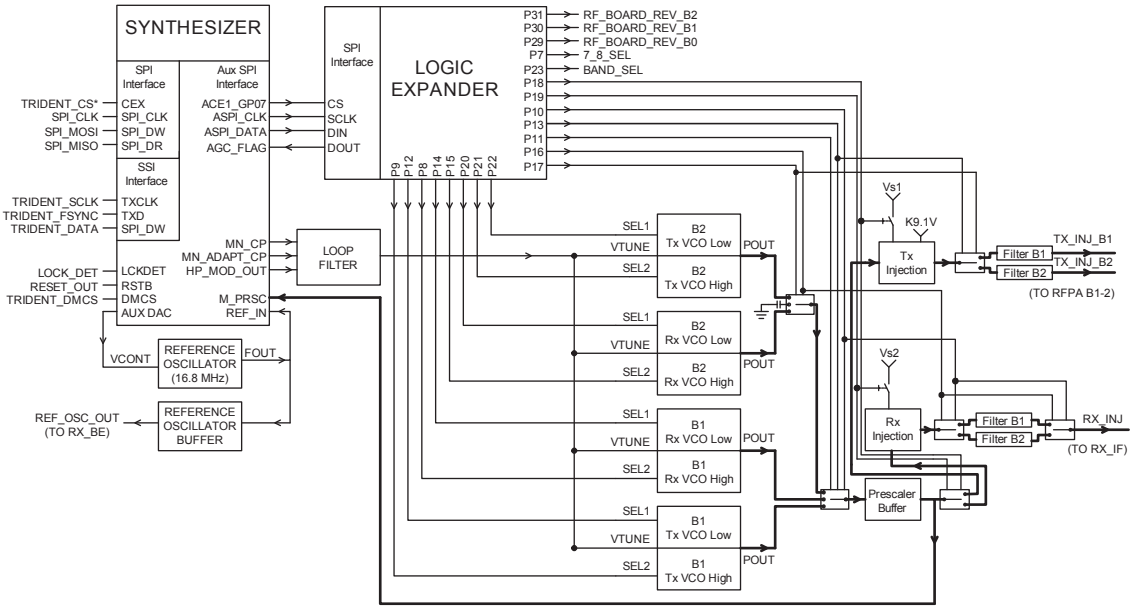
3.15.4
Receiver Back-End

The output of the IF circuit is fed directly to the back-end receiver IC.

This uses a variable-bandwidth bandpass sigma-delta architecture. It is capable of down-converting analog, as well as digital, RF protocols into a baseband signal, which is then transmitted over the Synchronous Serial Interface (SSI) bus. It also converts the 109.65 MHz signal from the IF section down to 2.25 MHz using a second LO frequency, which is produced by the second LO VCO. This VCO runs at 107.4 (low-side injection) or 111.9 MHz (high-side injection). The choice of frequency depends on known spurious interference related to the programmed received frequency.

3.16
Frequency Generation Unit

Figure 43: Configuration of the Dual Band Frequency Generation Unit for APX 5500/6500/7500/6500Li



The Dual Band Frequency Generation Unit (FGU) in Figure 43: Configuration of the Dual Band Frequency Generation Unit for APX 5500/6500/7500/6500Li on page 114 consists of the following:

- Daughter card PC board module containing the synthesizer IC and the 16.8 MHz reference oscillator
- Voltage Controlled Oscillator (VCO) modules (two per frequency band)
- Logic expander
- VCO buffer, amplifiers and filter circuits
- Associated circuits

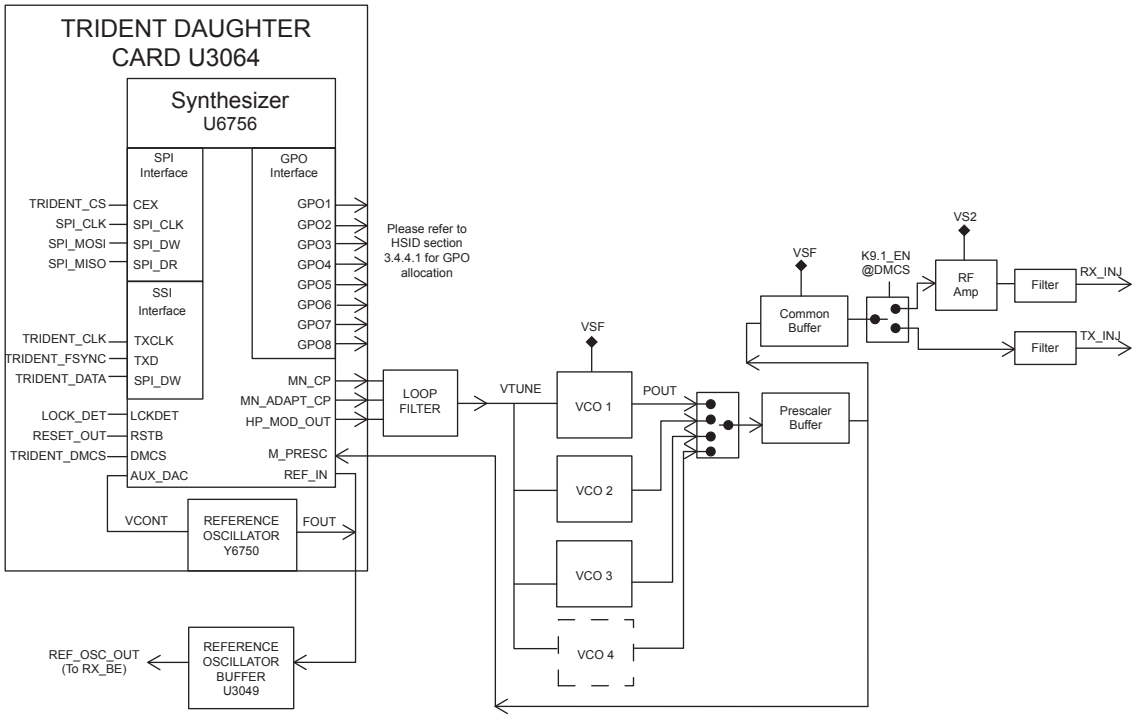
The Reference oscillator provides a frequency standard for the fractional-N synthesizer IC, the back-end receiver IC, and the controller section. The synthesizer programs the logic expander IC to select one of the VCO (determined by mode and frequency of operation), and tunes it to the receiver (RX), local oscillator injection (LO), or the transmitter (TX) carrier frequency.

The VCOs' are non-serviceable modules, each containing two oscillator circuits to cover the frequency bands of interest. For a dual band radio, there are two transmitters and two receiver VCO modules that cover the frequency bands designated as Band 1 and Band 2. The output of each module is connected to an RF switch, then to a prescaler buffer amplifier. The prescaler buffer feeds back to synthesizer IC, and switches to either TX and RX injection amplifiers.

In TX mode, the prescaler buffer amplifier output is switched to a two stage buffer. Before being injected into the power amplifier, the signal is switched to a band-dependent filter to reduce the spurious levels of the signals. The output of the filters is directly connected to the band-specific power amplifier. In RX mode, the prescaler is switched to another two stage buffer, and also band selectively filtered before being switched to the receiver mixer.

Modulation is accomplished by direct digital programming of the Fractional-N synthesizer by the SSI (Serial Synchronous Interface) to the controller.

Figure 44: Configuration of APX 2500/4500/4500Li/1500 Frequency Generation Unit



The Frequency Generation Unit (FGU) in Figure 44: Configuration of APX 2500/4500/4500Li/1500 Frequency Generation Unit on page 115 consists of the following:

- Daughter card PC board module containing the synthesizer IC and the 16.8 MHz reference oscillator
- Voltage Controlled Oscillator (VCO)
- VCO buffer, amplifiers, and filter circuits
- Associated circuits

The Reference oscillator provides a frequency standard for the fractional-N synthesizer IC, the back-end receiver IC, and the controller section. The synthesizer programs the internal GPO to select one of the VCO (determined by mode and frequency of operation), and tunes it to receiver (RX), local oscillator injection (LO), or the transmitter (TX) carrier frequency.

The output of each VCO is connected to an RF switch, then to a prescaler buffer amplifier. The prescaler buffer feeds back to the synthesizer IC, then supplies to common buffer amplifiers, and to an RF switch for TX or RX injection selection.

In TX mode, the common buffer amplifier output is switched to a band-dependent filter to reduce the spurious levels of the signals. The output of the filters is directly connected to the band-specific power amplifier. In RX mode, the common buffer amplifier output is switched to another stage buffer and also band selectively filtered before being switched to the receiver mixer.

Modulation is accomplished by direct digital programming of the Fractional-N synthesizer by the SSI (Serial Synchronous Interface) to the controller.

Chapter 4

Test Equipment, Service Aids, and Tools

This chapter provides lists of recommended test equipment, service aids, and tools. This also includes information that can be used in servicing and programming Motorola Solutions radios on the field.

4.1 Recommended Test Equipment

The list of equipment in the following table includes most of the standard test equipment that is required for servicing Motorola Solutions APX mobile radios.

This also includes several unique items designed specifically for servicing this family of radios.

The Characteristics column is included so that equivalent equipment can be substituted. If no information is provided in this column, the specific Motorola Solutions model listed is either a unique item or no substitution is recommended.

Table 28: Recommended Motorola Solutions Test Equipment

Motorola Solutions Model Number	Description	Characteristics	Application
R-1439 or R-1440 (See Table 29: Wattmeter Plug-In Elements on page 118 for plug-in elements)	BIRD Wattmeter (See Table 29: Wattmeter Plug-In Elements on page 118[2]	Power range: 100 mW to 100 W, 2 MHz to 1 GHz, UHF-F connector Power range: 100 mW to 100 W, 2 MHz to 1 GHz, N-female connector	Transmitter power measurements
R-1611	Dual-Channel 100 MHz Oscilloscope (Agilent)	Two-channel, 100MHz bandwidth, 200 M sample rate/sec, 2 MB memory/channel	Waveform measurements
Aeroflex 3920 (with options, as applicable)	System Analyzer	This item substitutes the items with an asterisk (*) in Table 30: Recommended Non-Motorola Solutions Test Equipment on page 118	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment

[2] The Wattmeter Plug-In Elements provide a listing of the plug-in elements that are available for the BIRD wattmeters listed here.

Table 29: Wattmeter Plug-In Elements

Power	25–60 MHz	50–125 MHz	100–250 MHz	200–500 MHz	400–1000 MHz
5 W	–	–	0180305F29	0180305F38	0180305F46
10 W	–	0180305F22	0180305F30	–	0180305F47
25 W	0180305F15	0180305F23	0180305F31	0180305F40	0180305F48
50 W	0180305F16	0180305F24	0180305F32	0180305F41	0180305F49
100 W	0180305F17	0180305F25	0180305F33	0180305F42	0180305F50
250 W	0180305F18	0180305F26	0180305F34	0180305F43	0180305F51
500 W	0180305F19	0180305F27	0180305F35	0180305F44	0180305F52
1000 W	0180305F20	0180305F28	0180305F36	0180305F45	0180305F53

The following table contains a listing of non-Motorola Solutions test equipment recommended for servicing mobile radios.

Table 30: Recommended Non-Motorola Solutions Test Equipment

Model Number	Description	Application
	1:1 Audio Transformer	Audio measurement (audio PA must NOT be grounded)
Agilent 6552	Power Supply (0–20 V, 0–25 A)	Mobile radio power supply and current measurements
Agilent 8901	Modulation Analyzer	Reference frequency measurements
*General Dynamics R8000B	Digital Radio Test Set	Frequency, reference oscillator deviation digital tests and compensation measurements
Agilent U8903A and Rohde & Schwarz UPV	Audio Analyzer	Audio signal-level, SINAD, and distortion measurements
Keithly 2015-D	Audio Analyzing DMM	AC/DC voltage and distortion measurements
Fluke 187 or 189	Handheld Digital Multimeter (True RMS, AC, AC+DC, dB)	AC/DC voltage and current measurements
Fluke 190 Series	Handheld Oscilloscope (60–200 MHz Bandwidth, 2.5 GS/sec, Built-in 500-Count True RMS Multimeter)	Waveform measurements
Weinschel 49 30 43	30 dB RF Attenuator	For tests that require a modulation analyzer or wattmeter

4.2 Service Aids and Recommended Tools

This topic covers the listing and description of the service aids and tools designed specifically for servicing mobile radios, and the common tools required to disassemble and maintain the radio well.

These kits and/or parts are available from the Motorola Solutions parts division offices listed in Appendix A, B, C, and D accordingly.

Table 31: Service Aids for Mobile Radios

Motorola Solutions Part Number	Description	Application
0105953U15	Force Fail Board (Not applicable for APX 2500/APX 4500/APX 4500Li)	Radio set in bootstrap mode for radio flashing/programming.
84009287001	APX 5500/APX 6500/APX 7500/APX 6500Li Service Flex	Connects controller board to RF board for analysis of either board while the other remains in the radio chassis.
0104054J56	APX 2500/APX 4500/APX 4500Li/APX 1500 Service Flex	
DVN4236_	APX FLASHport Firmware CD	Kit with firmware to upgrade the radio, APX FLASHport CD.
DVN4237_	APX 7500 FLASHport Kit	Kit with firmware to upgrade the radio, APX FLASH port kit.
DVN4299_	APX 2500/APX 4500/APX 4500Li/APX 1500 FLASHport Kit	
RVN5224_	APX Customer Programming Software (CPS) and Tuner Software	Programming and radio alignment software.
HKN6122_	4-wire RS232 data cable	Cable for data applications through the TIB J600 connector, remote mount only.
HKN6160_	1.8 m (6 ft) 4-wire RS232 data cable	1.8 m (6 ft) cable used for RS232 data applications through the 26 pin rear accessory connector. Also provides an Ignition sense (ACC) wire.
HKN6161_	6.1 m (20 ft) 4-wire RS232 data cable	6.1 m (20 ft) cable used for RS232 data applications through the 26 pin rear accessory connector (J2).
HKN6163_	1.8 m (6 ft) USB data cable	1.8 m (6 ft) cable used for USB programming and data applications through the 26 pin rear accessory connector (J2) or the J100 remote control head connector. Also provides Ignition sense (ACC) and speaker wires. An emergency jumper wire must be installed between pins 15 (emergency) and 1 (gnd) when used in dash mount applications.
HKN6172_	4.5 m (15 ft) USB data cable	4.5 m (15 ft) cable used for USB programming and data applications through the 26 pin rear accessory connector (J2) or the J100 remote control head connector. An emergency jumper wire must be installed between pins

Motorola Solutions Part Number	Description	Application
		15 (emergency) and 1 (gnd) when used in dash mount applications.
HKN6182_	MMP Cable Adapter for Keyloader	Use with TIB MMP or dash-mount control head MMP. Must be combined with KVL cable TKN8531_
HKN6183_	2-wire MMP RS232 Data Cable	Cable for RS232 data applications through the control head or TIB MMP.

Table 32: Recommended Motorola Solutions Tools for APX Mobile Radios

Motorola Solutions Part Number	Tools and Supplies
0180320B16	Magnetic screwdriver set with bits
0180706J23	Chassis eliminator (Mid Power)
0180706J24	Chassis eliminator (High Power)
0104057J53	APX 2500/APX 4500/APX 4500Li Chassis Eliminator Enclosures (Mid Power)
Refer to Table 33: APX 2500/APX 4500/APX 4500Li/APX 1500 Chassis Eliminator Internal Assemblies on page 122	APX 2500/APX 4500/APX 4500Li Chassis Eliminator Internal Assemblies
3085651A01	Mini-UHF to N-type adapter cable
6686119B01	Plastic scraping tool
6680163F01	Removal and insertion tool
RSX4043	Roto-Torq adjustable torque driver

Motorola Solutions Part Number	Description	Application
R1453	Digital-readout solder station	Digitally controlled soldering iron
RLN4062	Hot-air workstation, 120 V	Tool for hot-air soldering/desoldering of surface-mounted integrated circuits
0180386A78	Illuminated magnifying glass with lens attachment	Illumination and magnification of components
0180302E51	Master lens system	
	Anti-static grounding kit	Used during all radio assembly and disassembly procedures
6684253C72	Straight prober	
6680384A98	Brush	
1010041A86	Solder (RMA type), 63/67, 0.5 mm diameter, 1 lb. spool	
0180303E45	SMD tool kit (included with R1319A)	

Motorola Solutions Part Number	Description	Application
R1319	ChipMaster (110V)	Surface-mount removal and assembly of surface-mounted integrated circuits and/or rework station shields. Includes 5 nozzles.
R1321	ChipMaster (220V)	
R1364	Digital heated tweezer system	Chip component removal
R1427	Board preheater	Reduces heatsink on multi-level boards
6680309B53	Rework equipment catalog	Contains application notes, procedures, and technical references used to rework equipment
ChipMaster Options:		
6680370B54	0.710 in. x 0.710 in.	Heat-focus heads for R1319 workstation
6680370B57	0.245 in. x 0.245 in.	
6680370B58	0.340 in. x 0.340 in.	
6680371B15	0.460 in. x 0.560 in.	
ChipMaster Nozzles:		
6680333E28	PA nozzle	Soldering and unsoldering ICs
6680332E83	PLCC-28 [3] nozzle	
6680332E93	PLCC-32 nozzle	
6680332E82	PLCC-44[3] nozzle	
6680332E94	PLCC-52 nozzle	
6680332E95	PLCC-68[3] nozzle	
6680332E96	PLCC-84 nozzle	
6680332E89	QFP-80 nozzle	
6680332E90	QFP-100[3] nozzle	
6680332E91	QFP-132[3] nozzle	
6680334E67	QFP-160 nozzle	
6680332E86	SOIC-14/SOL-16J nozzle	
6680333E46	SOL-18 nozzle	
6680332E84	SOIC-20 nozzle	
6680332E87	SOL-20J nozzle	
6680333E45	SOL-24 nozzle	
6680332E88	SOL-28J nozzle	
6680333E54	TSOP-32 nozzle	
6680333E55	TSOP-64 nozzle	

[3] Included with ChipMaster packages.

Table 33: APX 2500/APX 4500/APX 4500Li/APX 1500 Chassis Eliminator Internal Assemblies

Part Number	Description	Quantity
0104054J54	Assembly, Screw, Sealing	12
0310909A33	Screw, Heat Spreader	3
4285702E01	Clip, RF & DC Connectors	2
3015953H02	Cable, GPS	1
0371838H01	Screw, D-Sub for accessory connector	2
0104052J27	Flex Assembly, Accessory Connector	1
1110022D23	Thermal grease	1
75012190001	Pad, Thermal	2
0104054J56	APX 2500/APX 4500/APX 4500Li Extended Flex Assembly	1

NOTE: Refer to leaflet part number *68012008056* for more details of APX 2500/APX 4500/APX 4500Li/APX 1500 Chassis Eliminator.

Table 34: Recommended Non-Motorola Solutions Tools for APX Mobile Radios

Part Number	Tools and Supplies
MA-800G	Solder aid, (black stick), Hexacon Electric Co.
	Flat-blade screwdriver
	Small, flat-blade screwdriver
	Torx® T10 and T20 bits
	Anti-static grounding kit

4.3 Mobile Radios Field Programming and Equipment

The mobile radios can be aligned and programmed in the field. This requires specific equipment and special instructions. Refer to the online help in Customer Programming Software (CPS) and Tuner Software (RVN5224_).

The radios use a flash-memory device to store information about frequencies, squelch codes, signaling codes, time-out timer durations, and other parameters and can be programmed in the field for any number of times without removing the flash memory from the radio.

The mobile radios can only be programmed using a USB. To program the radio, connect the USB cable HKN6184_ to the control head Mobile Microphone Port (MMP) connector. This is the 10-pin connector to which the microphone is commonly attached. The MMP connector is below the volume knob and to the left of the LCD display. HKN6163_ and HKN6172_ USB cables can also be used for radio programming, and can be connected at the remote control head J100 or radio rear J2 connectors. Refer to the *CPS Programming Installation Guide* (Motorola Solutions part number 6881095C44) for installation and setup procedures for the software.

Once the computer is connected to the radio, the prompts provided by the programming software can be followed. The following items, available through the Radio Products Services Division (except the computer), are required when programming mobile radios.

Table 35: Mobile Radios Field-Programming Items

Type or Part Number	Description
Customer Programming Software (CPS) and Tuner Software (RVN5224_)	This software enables you to program the radio features and align its parameters.
Personal Computer (PC)	Operating System • Windows® XP with Service Pack 3, or above • Windows® Vista with Service Pack 2, or above • Windows® 7 with Service Pack 1, or above • Windows® 8 Minimum Hardware Requirements • 1 GHz dual core or higher Pentium grade processor • 2 GB RAM memory, excluding onboard graphics card memory usage • 2 GB free hard disk space (for Standalone CPS) or 4 GB for CPS with Radio Management Suite. • DirectX 9-class graphics card • USB (Universal Serial Bus) Port radio communication • USB (Universal Serial Bus) Port for iButton dongle • DVD-ROM drive for software installation
USB Programming Cable	Used to connect radio directly to the computer, refer to Table 31: Service Aids for Mobile Radios on page 119.

Chapter 5

Performance Checks

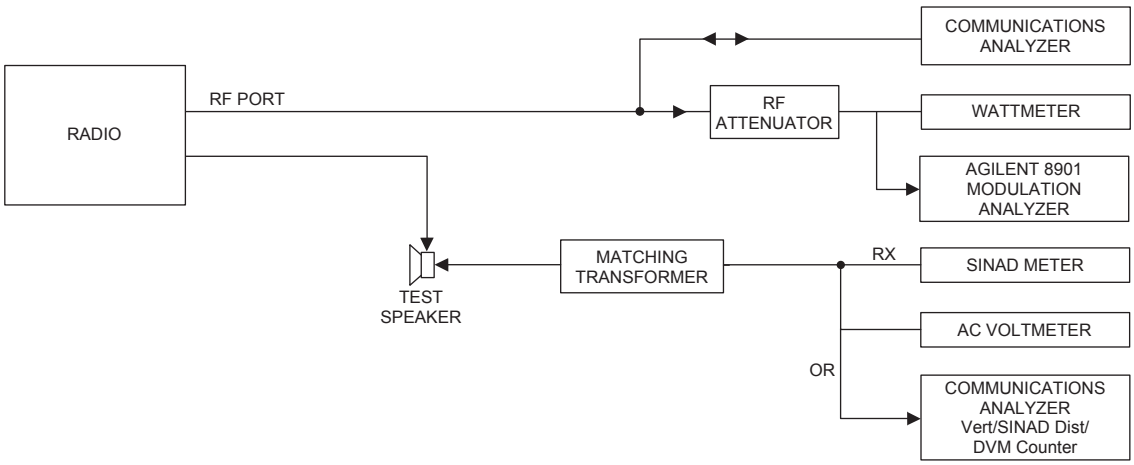
This section covers performance checks used to verify that the radio meets published specifications.

The recommended test equipment listed in Test Equipment, Service Aids, and Tools on page 117 approaches the accuracy of the manufacturing equipment, with a few exceptions. Accuracy of the equipment must be maintained in compliance with the manufacturer's recommended calibration schedule.

5.1 Test Setup

The equipment required for APX mobile radio performance checks is connected as shown in Figure 45: Performance Checks Test Setup on page 124.

Figure 45: Performance Checks Test Setup



5.2 Test Mode

CAUTION: Be sure to transmit into a series load when keying a radio under test such as 30 dB RF pad). Failure to do so can result in test equipment damage.

5.2.1 Entering Test Mode

Procedure:

1. Turn the radio on.
2. Within 10 seconds after Self Test is complete, press the **Home Button** five times in succession for O2/O5/O7/O9/E5 Control Head (see O2 Control Head Test Mode on page 128 for O2, O5 Control Head Test Mode on page 131 for O5, O7 Control Head Test Mode on page 133 for O7 and O9 Control Head Test Mode on page 135 for O9 Control Head, see E5 Control Head Test

Mode on page 132 for E5), or press the **Side Button 2** five times in succession for O3 Control Head (see O3 Control Head Test Mode on page 129).

The radio shows a series of displays that gives information regarding various version numbers and subscriber-specific information. The displays are described in Table 36: Test-Mode Displays on page 125.

Table 36: Test-Mode Displays

Display Name	Description	Appears
SERVICE	Indicates radio has entered test mode	Always
HOST VERSION	Version of radio firmware	Always
DSP VERSION	Version of radio DSP firmware	Always
Secure Version	Firmware version for encryption	When radio is secure-equipped
Encryption Mode	Type of encryption being used	When radio is secure-equipped
CH VERSION	Version of Control Head firmware	Always
MCHB Version	Version of Control Head Board	Always
CHIB Version	Version of Control Head Interface Board	When auxiliary control head is present/radio is remote mount
Auxiliary Control Head	Firmware version for auxiliary control head	When auxiliary control head is present
Siren Version	Firmware version for siren	When siren is present
VRS Version Number	Firmware version for VRS	When VRS is present
MODEL NUMBER	Radio model number, as programmed in codeplug	Always
SERIAL NUMBER	Radio serial number, as programmed in codeplug	Always
ESN	Electronic Serial Number	Always
ROM Size	Memory capacity of flash part	Always
FLASHCODE	FLASHcodes, programmed as a part of radio codeplug	Always
RF BAND	Frequency band of radio	Always
TUNING VER	Version of Codeplug tuning	Always

Display Name	Description	Appears
PROCESSOR VER	Version of radio microprocessor	Always

NOTE:
All displays are temporary and expire without any user intervention. If the information is longer than the physical length of the control head display, it wraps around to the next display. After the last display, RF TEST is displayed.

Special attention: While information is scrolling in the test mode, if the **UP** button is pressed, the scrolling information pauses until the **DOWN** button is pressed again. Repeat with **UP** button to pause any other information. This makes recording radio version information easier.

3 Turn the **Mode** Rotary Knob for O2/O5/O7/O9/E5 Control Head.

The display shows CH TEST.

4 Press the **Home** button to enter the RF test mode.

The display shows 1 CSQ indicating test frequency 1, Carrier SQuelch mode.

5 For the O3 Control Head, press the programmed **Monitor** button to enable toggling between RF TEST and CH TEST.

6 Press the **Orange (EMERG)** button to select RF TEST.

The display shows 1 CSQ indicating test frequency 1, Carrier SQuelch mode.

5.2.2
RF Test Mode

A special routine called **RF TEST MODE** or air test has been incorporated into the radio.

Procedure:

1 For the O2/O5/O7/O9/E5 Control Head, enter the RF test mode by pressing the **Home** button when the test mode menu RF TEST is displayed. If RF TEST is not displayed, use the **Mode** knob or the navigation button to scroll through the test mode menu until RF TEST is displayed.

2 For the O3 Control Head, enter the RF test mode by pressing the **Orange (EMERG)** button when the test mode menu RF TEST is displayed. If RF TEST is not displayed, use the **Monitor** button to toggle between RF TEST and CH TEST.

3 For the O2/O5/O7/O9/E5 Control Head, press the **Home** button to move the cursor back and forth between the frequency and signaling type. Use the **Mode** knob to scroll through the available selections.

4 For the O3 Control Head, press the **Monitor** button to select Channel Spacing (12.5 kHz or 25 kHz), press the **Side Button 1** to change signaling type, and press **Side Button 2** to change frequency.

Table 37: Rx Test Frequencies

Rx Freq #	VHF 50 W/100 W	UHF R1 40 W/100 W	UHF R2 45 W	700–800 MHz 35 W	900 MHz 33 W
F1	136.0625	380.0625	450.0625	762.0625	935.0625

Rx Freq #	VHF 50 W/100 W	UHF R1 40 W/100 W	UHF R2 45 W	700–800 MHz 35 W	900 MHz 33 W
F2	140.8125	389.0625	455.0625	769.0625	938.0625
F3	145.5625	405.0625	465.0625	775.9375	940.9375
F4	150.3125	415.0625	470.0625	851.0625	935.0625
F5	154.9375	424.9375	484.9375	860.0625	938.0625
F6	155.0625	425.0625	485.0625	860.0625	940.9375
F7	159.8125	440.0625	498.0625	869.9375	935.0625
F8	164.5625	455.0625	511.9375	851.0625	938.0625
F9	169.3125	465.0625	512.0625	860.0625	940.9375
F10	173.9375	469.9375	519.9375	869.9375	935.0625

Table 38: Tx Test Frequencies

Tx Freq #	VHF 50 W/100 W	UHF R1 40 W/100 W	UHF R2 45 W	700–800 MHz 35 W	900 MHz 33 W
F1	136.0125	380.0125	450.0125	762.0125	896.0125
F2	140.7625	389.0125	455.0125	768.9875	898.0125
F3	145.5125	405.0125	465.0125	776.0125	900.9875
F4	150.2625	415.0125	470.0125	793.9875	901.0125
F5	154.9875	424.9875	484.9875	805.9125	901.9875
F6	155.0125	425.0125	485.0125	806.0125	935.0125
F7	159.7625	440.0125	498.0125	823.9875	937.0125
F8	164.5125	455.0125	511.9875	851.0125	939.9875
F9	169.2625	465.0125	512.0125	860.0125	940.0125
F10	173.9875	469.9875	519.9875	869.8875	940.9875

Table 39: Signaling Types

Display	Modulation	Demodulation	Type
CSQ	None	None	Carrier Squelch
TPL	192 Hz	192 Hz	Private-Line
AST	1200 Hz	N/A	ASTRO (digital)
USQ	None	None	Open Squelch

When in the transmit test mode, DTMF modulation produces a sidetone in the speaker. All signaling types continually modulates the transmitted signal for detection or measurement by external instruments.

5.2.3

O2 Control Head Test Mode

The control head test mode is part of the diagnostics built into the radio. It is entered through the front-panel programming sequence. Test mode allows you to perform button and display tests to verify proper operation.

Procedure:

1. Enter the control head test mode by pressing the **Power** button. Press the **Menu Select** button **1** and **4** simultaneously to enter control head STANDALONE TEST.

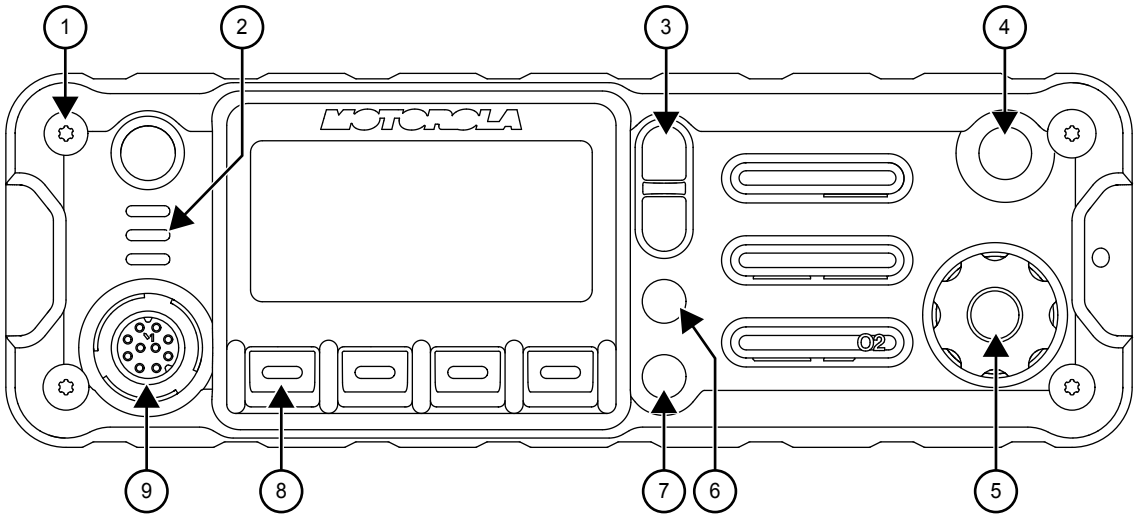
   CH firmware, CH FPGA, CH Flashzap version, and CH Board version are displayed before the unit enters the Control Head Test mode.

2. Press **Home** to enter sequential test.
3. In the **Factory Test** menu, pressing any button activates the following tests:
   - LED test (green, red, and yellow)
   - Backlight test (Off, Medium, and On)
   - LCD test (four borders test)
   - Keypad LED test (green, amber, red, and common white LED test)
4. Press any button to activate the keypad test.

   All the ten buttons notations are displayed on the LCD. When the corresponding button is pressed, the notation disappears from the LCD.

5. Press any key to enter **Multifunction Knob** test after all ten buttons are pressed.
6. Turn the radio off and then turn the radio on to exit test mode and return to normal radio operation.

Figure 46: O2 Control Head



No.	Description
1	Power On/Off Button
2	LED Status Indicators
3	Up/Down Buttons

No.	Description
4	Emergency Button
5	Multi-Function Knob
6	Dim Button
7	Home Button
8	Menu Select Buttons
9	Accessory Port (Microphone)

5.2.4
O3 Control Head Test Mode

The control head test mode is part of the diagnostics built into the radio. It is entered through the front-panel programming sequence. Test mode allows you to perform button and display tests to verify proper operation.

Procedure:

1. Enter the control head test mode by pressing the **POWER ON/OFF** button while holding down the **1** and **3** button of the keypad. Release the **1** and **3** button when `Standalone Mode` is displayed.

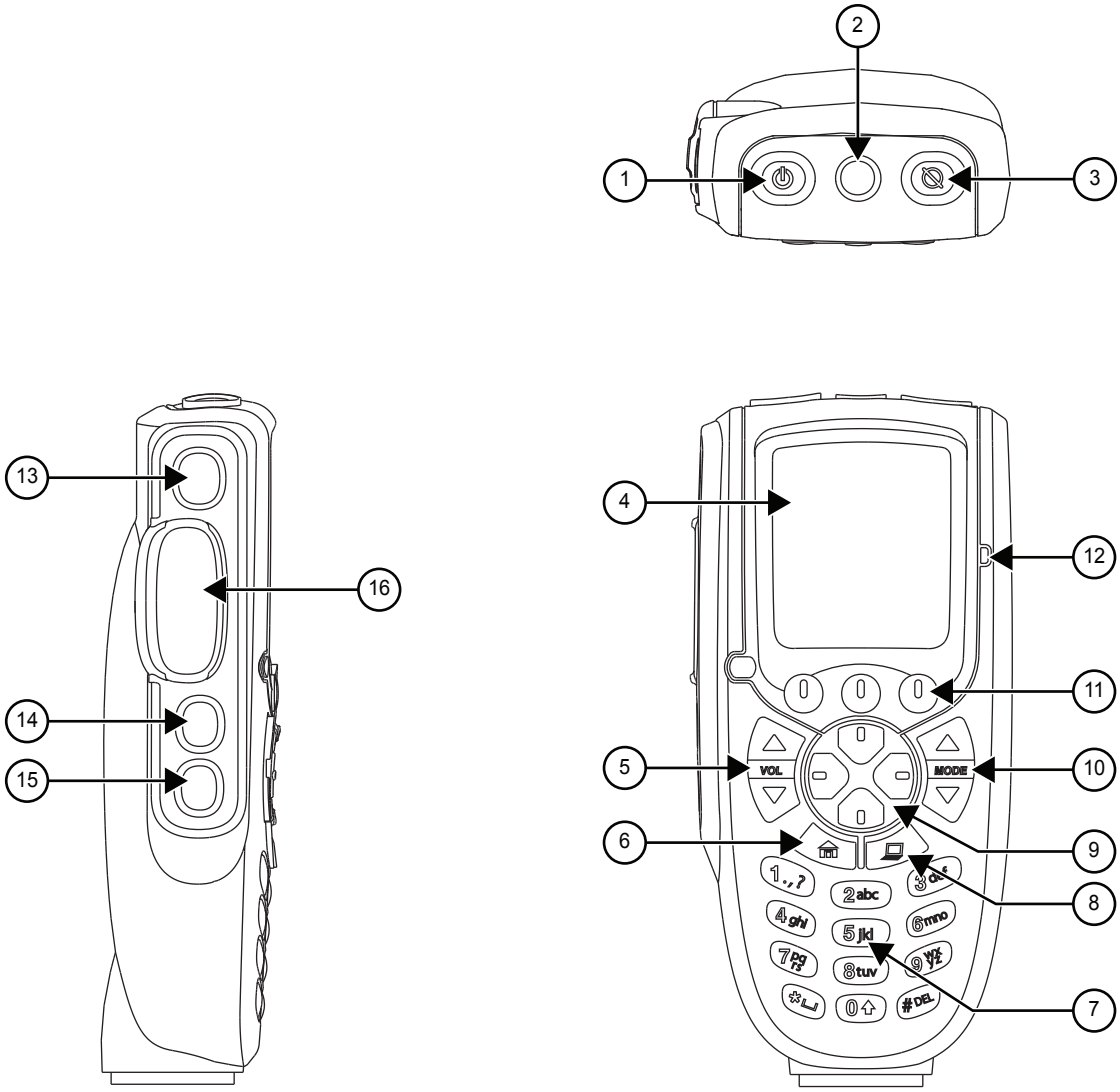
   The versions for CH Firmware, CH FPGA, CH Flashzap, and CH Board are displayed before the unit enters Factory Test.

2. In the **Factory Test** menu, pressing any button activates the following tests:
   - LED test (green, red, and yellow)
   - Backlight test (Off, Medium, and On)
   - LCD test (4 borders test)
3. After the LCD test, place the Hook Up and remove the Hook Up until Hook Off is shown.
4. Press any button to activate the 32 buttons to test the Keypad Buttons, Side Buttons, and Top Buttons.

   All the 32 Buttons notations are displayed on the LCD. When the corresponding button is pressed, the notation disappears from the LCD. Radio displays `Test Completed` after all 32 buttons are pressed.

5. Press the **POWER ON/OFF** to turn the control head off.
6. Turn the radio off and then turn the radio on to exit test mode and return to normal radio operation.

Figure 47: O3 Control Head



No.	Description
1	Power On/Off Button
2	Orange Button
3	Programmable Button
4	14-Character Display
5	Volume Rocker
6	Home Button
7	Keypad
8	Data Button
9	Navigation Keys
10	Mode Rocker

No.	Description
11	Programmable Soft Keys
12	LED Indicators
13	Programmable Button (Monitor)
14	Side Button 1 (Programmable)
15	Side Button 2 (Programmable)
16	Push-to-Talk Button

5.2.5

O5 Control Head Test Mode

The control head test mode is part of the diagnostics built into the radio. It is entered through the front-panel programming sequence. Test mode allows you to perform button and display tests to verify proper operation.

Procedure:

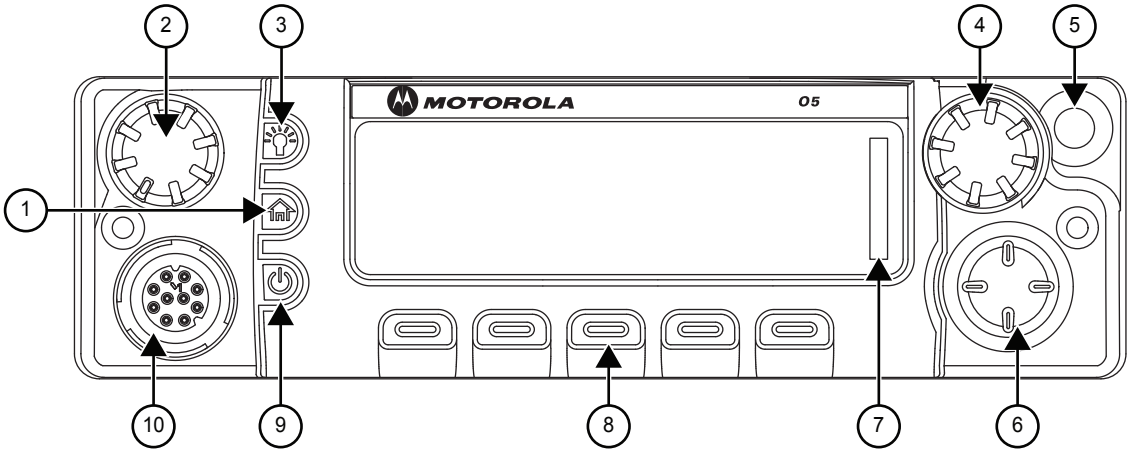
1 After power up, press the **HOME** button five times to enter the **Test Mode** menu.

NOTE: Once **CH TEST** has been selected by pressing **Home**, turning the **Mode** knob does not change the control head test mode back to the RF test mode. You must turn the radio off and re-enter the RF test mode as described earlier.

2 When the control head test mode has been selected, all the icons across the top of the LCD are displayed briefly. The indicator LED on the right side will also light up briefly. Press any of the control head buttons or turn the knobs to display the button or knob ID. The value of the button or knob is also displayed. The value of a button is 1 for a press and 0 for a release.

3 Turn the radio off and then turn on the radio to exit test mode and return to normal radio operation.

Figure 48: O5 Control Head



No.	Description
1	Home
2	Volume Knob
3	Dim Button

No.	Description
4	Mode Knob
5	Emergency
6	Navigation Keys
7	Indicators
8	Soft Menu Keys
9	Power On/Off
10	MMP Connector

5.2.6

E5 Control Head Test Mode

The control head test mode is part of the diagnostics built into the radio. It is entered through the front-panel programming sequence. Test mode allows you to perform button and display tests to verify proper operation. For test mode, the control head must be standalone, not connected to brick.

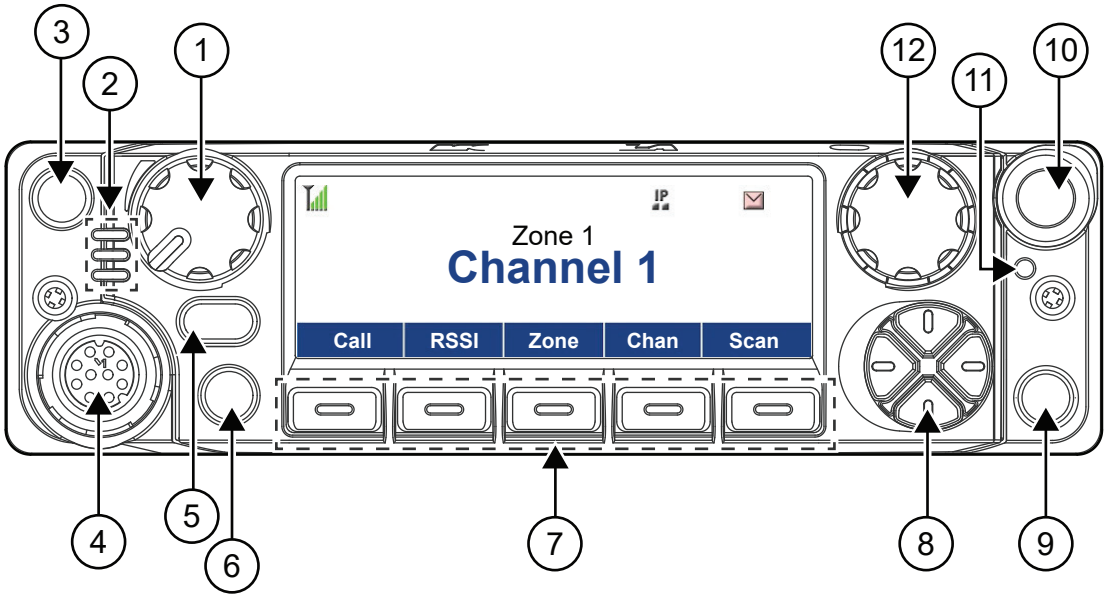
Procedure:

1. Press and hold the **Menu Select Buttons 2** and **Menu Select Buttons 5** simultaneously, then press the **Power** button to enter control head Standalone Test.

   The control head displays CH firmware, CH FPGA, CH Flashzap version, and CH Board version before entering the Control Head test mode.

2. Press **Home** button to enter sequential test.
3. In the **Factory Test** menu, pressing any buttons will activate the following tests:
   - LED test (green, red, and yellow)
   - Backlight test (0%, 3%, 8%, 15%, 22%, 44%, 70%, 94%)
   - LCD test (4 borders test)
   - Keypad LED test (green, amber, red, and common white LED test)
4. Hit any button after this to activate the keypad test. Pressing any of the control head buttons or turning the knobs will display the button or knob ID. The display also shows the value of the button or knob. The value of a button is 1 for a press and 0 for a release.
5. Then press next to enter volume and frequency knob test.
6. Turn the radio off and then turn on the radio to exit test mode and return to normal radio operation.

Figure 49: E5 Control Head



No.	Description
1	Volume Knob
2	Led Status Indicators
3	Power On/Off
4	MMP Connector
5	Dim Button
6	P Button
7	Menu Select Buttons
8	4-Way Navigation Button
9	Home Button
10	Emergency Button
11	Bluetooth Pairing Location Indicator
12	Mode Knob

5.2.7

O7 Control Head Test Mode

The control head test mode is part of the diagnostics built into the radio. It is entered through the front-panel programming sequence. Test mode allows you to perform button and display tests to verify proper operation.

Procedure:

1 Power up the control head by pressing the **Power** button. Press the **Menu Select** button **1** and **4** simultaneously to enter control head **STANDALONE TEST**.

CH firmware, CH FPGA, CH Flashzap version, and CH Board version are displayed before the unit enters the Control Head Test mode.

2 Press **Home** to enter sequential test.

3 In the **Factory Test** menu, pressing any buttons activates the following tests:

- LED test (green, red, and yellow)
- Backlight test (Off, Medium, and On)
- LCD test (four borders test)
- Keypad LED test (green, amber, red, and common white LED test)

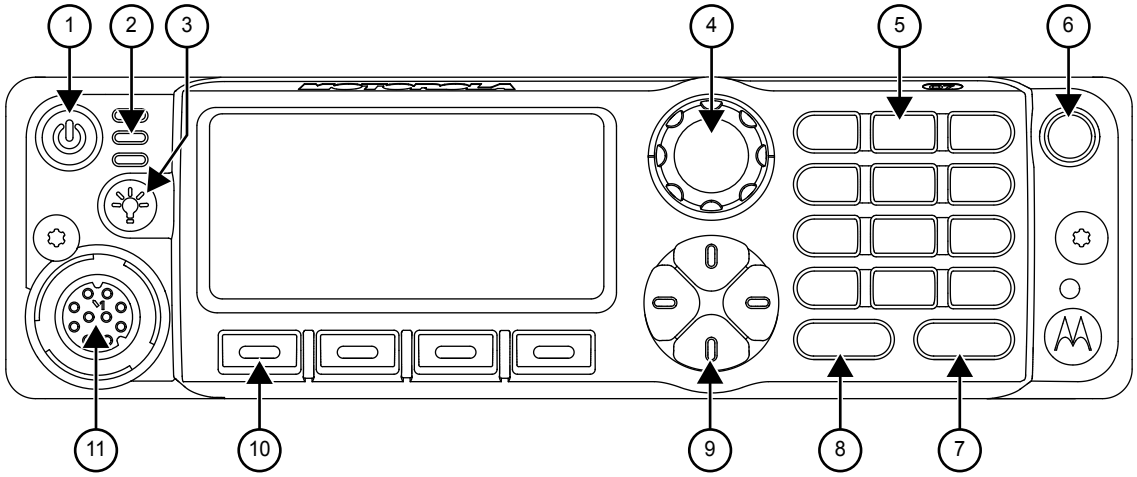
4 Press any button to activate the keypad test.

All the 24 buttons notations are displayed on the LCD. When the corresponding button is pressed, the notation disappears from the LCD.

5 Press any key to enter the **Multifunction Knob** test after all 24 buttons are pressed.

6 Turn the radio off and then turn the radio on to exit test mode and return to normal radio operation.

Figure 50: O7 Control Head



No.	Description
1	Power On/Off Button
2	LED Status Indicators
3	Dim Button
4	Multi-Function Knob
5	DTMF Keypad
6	Emergency Button
7	Data Button
8	Home Button
9	Navigational Keys
10	Menu Select Buttons
11	Accessory Port (Microphone)

5.2.8

O9 Control Head Test Mode

The control head test mode is part of the diagnostics built into the radio and is entered through the front-panel programming sequence. Test mode allows you to perform button and display tests to verify proper operation.

Procedure:

1. Power up the control head by pressing the **Power** Button. Press the **Soft Menu Keypad** buttons **2** and **5** simultaneously to enter control head **STANDALONE TEST**.

   CH firmware, CH FPGA version, CH Flashzap version, and CH Board version are displayed before the unit enters the
   Factory Test.

2. Press **Home** to enter sequential test.
3. In **Factory Test** menu, pressing any button activates the following tests:
   - LED test (green, red, and yellow)
   - Backlight test (Off, Medium, and On)
   - LCD test (4 borders test)
   - Keypad LED test (green, amber, red, and common white LED test)
4. Press any button to activate the keypad test.

   All the 48 buttons notations are displayed on the LCD and once the corresponding button is pressed, the notation disappears from the LCD.

5. Press any key to enter Rotary test after all 48 buttons are pressed. Response selector, Volume rotary, and Channel rotary functionality is tested by turning the knob.
6. Turn the radio off and then turn the radio on to exit test mode and return to normal radio operation.

Figure 51: O9 Control Head

No.	Description
1	Programmable Buttons (Top)
2	Power On/Off Button
3	LED Indicators
4	Status Icons
5	Display Backlight Control Buttons
6	Menu Select Buttons
7	Volume Knob
8	Programmable Buttons (Bottom)
9	Home Button
10	Mode Knob
11	Data Feature Button
12	4-Way Navigation Button

No.	Description
13	Keypad
14	Public Address Button
15	Orange Button
16	Directional Buttons
17	Response Selector
18	Siren Control Buttons

5.3 Receiver Performance Checks

Table 40: Receiver Performance Checks

Test Name	System Analyzer	Radio	Test Condition	Comments
Reference Frequency	Mode: PWR MON channel test frequency (See RF Test Mode on page 126[4]) Monitor: Frequency error Input at RF In/Out	TEST MODE, 1 CSQ output at antenna. 900 MHz only: Use 12.5 kHz channel spacing	Press and hold **PTT** switch.	Maximum Frequency error is ± 1.5 PPM for 700/800 MHz and 800/900 MHz ± 1.0 PPM for 900 MHz
Rated Audio	Mode: GEN Output level: 1.0 mV RF Channel test frequency (See RF Test Mode on page 126[4]) Mod: 1 kHz tone at 3 kHz deviation Monitor: DVM, AC Volts	TEST MODE, 1 CSQ. Use 12.5 kHz channel spacing	Release **PTT** switch.	Set volume control to 6.45 Vrms across the 3.2 Ω speaker or 7.75 Vrms across the 8 Ω speaker
Distortion	As above, except to distortion	As above	Release **PTT** switch.	Distortion <= 3.0%
Sensitivity (SINAD)	As above, except SINAD, lower the RF level for 12 dB SINAD	As above	Release **PTT** switch.	RF input to be < 0.25 µV

[4] Test frequencies are listed in RF Test Mode

Test Name	System Analyzer	Radio	Test Condition	Comments
Noise Squelch Threshold (only radios with conventional system need to be tested)	RF level set to 1 mV RF	As above	Release **PTT** switch.	Set volume control to 3.16 Vrms across the speaker.
	As above, except change frequency to a conventional system. Raise RF level from zero until radio unsquelches.	Out of TEST MODE; select a conventional system	Release **PTT** switch.	Unsquelch to occur at < 0.25 µV

5.4 Transmitter Performance Checks

Table 41: Transmitter Performance Checks

Test Name	System Analyzer	Radio	Test Condition	Comments
Reference Frequency	Mode: PWR MON channel test frequency (See RF Test Mode on page 126 [4]) Monitor: Frequency error Input at RF In/Out	TEST MODE, 1 CSQ. 900 MHz only: Use 12.5 kHz channel spacing	Press and hold PTT switch.	Maximum Frequency error is ± 1.5 PPM for 700/800 MHz and 800/900 MHz ± 1.0 PPM for 900 MHz
Power RF	As above	As above	Press and hold **PTT** switch.	Refer to the Radio Specifications in the front of the manual.
Voice Modulation	Mode: PWR MON first channel test frequency (See RF Test Mode on page 126[4]) attenuation to -70, input to RF In/Out Monitor: DVM, AC Volts Set 1 kHz Mod Out level for 25	As above	Press and hold **PTT** switch.	Deviation: VHF, 700/800 MHz: >=2.5 kHz but <= 3.5 kHz 900 MHz: >=1.0 kHz but <= 2.0 kHz

Test Name	System Analyzer	Radio	Test Condition	Comments
	mVrms at test set, 80 mVrms at dummy microphone or load box input			
Voice Modulation External Microphone	Mode: PWR MON first channel test frequency (See RF Test Mode on page 126[4]) attenuation to -70, input to RF In/Out	As above	Connect external microphone. Press and hold **PTT**.	Press **PTT** switch on microphone and say “four” loudly into the radio mic. 900 MHz: >=1.0 kHz but <= 2.0 kHz
PL Modulation (radios with conventional, clear mode, coded squelch operation only)	Change frequency to channel test frequency (See RF Test Mode on page 126[4]) B/W to narrow	TEST MODE, 1 TPL	Remove modulation input from dummy microphone or load box. Press and hold **PTT** switch.	900 MHz: >=375 kHz but <= 500 kHz
Talkaround Modulation (radios with conventional, clear mode, talkaround operation only)	Change frequency to conventional talkaround frequency. Mode: PWR MON deviation, attenuation to -70, input to RF In/Out Monitor: DVM, AC Volts Set 1 kHz Mod Out level for 80 mVrms at dummy microphone or load box.	Conventional talkaround personality (clear mode operation) 1 CSQ	Press and hold **PTT** switch.	
Talkaround Modulation (radios with conventional, secure mode, talkaround operation only)[5]	Change frequency to conventional talkaround frequency. Mode: PWR MON deviation, at-	Conventional talkaround personality (secure mode operation). Load key into radio 1 sec.	Press and hold **PTT** switch.	

Test Name	System Analyzer	Radio	Test Condition	Comments
	tenuation to -70, input to RF In/Out Monitor: DVM, AC Volts Mod: 1 kHz out level for 80 mVrms at dummy microphone or load box.			

[5] The secure mode, talkaround modulation test is only required for radios that do not have clear mode talkaround capability.

Chapter 6

Radio Alignment Procedures

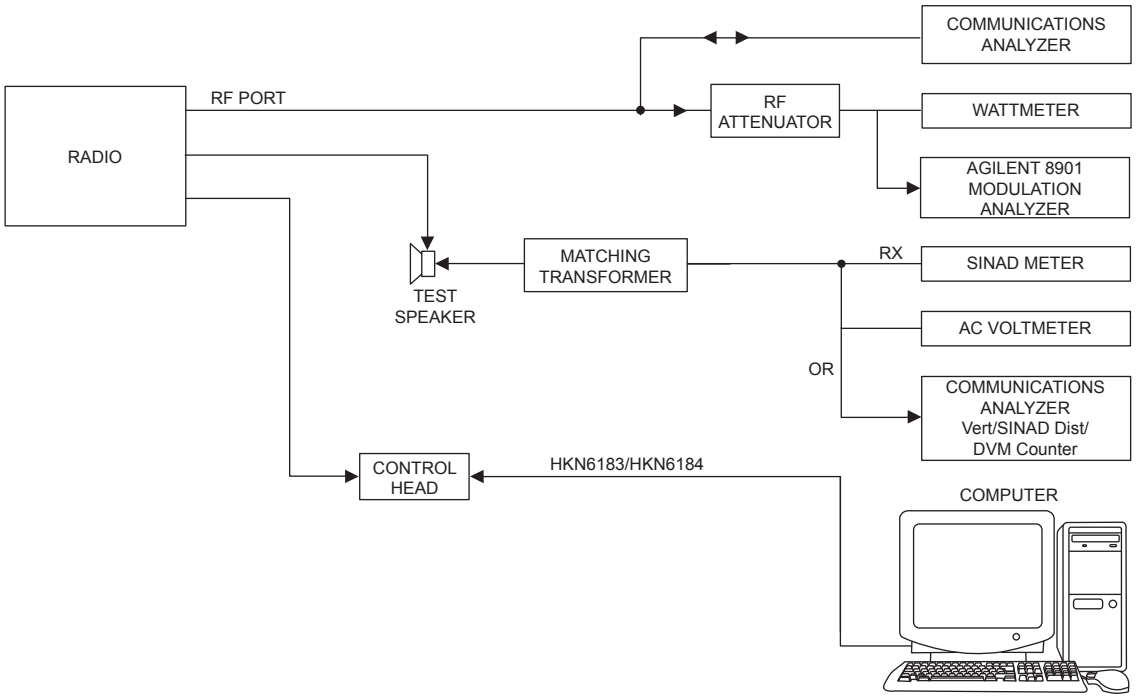
This section describes both receiver and transmitter radio alignment procedures. You are required to perform all the alignments in this section after replacing (or servicing) the transceiver or transmitter boards.

6.1 Navigating the Tuner Program

A personal computer (PC) and Tuner Software are required to align the radio. Refer to the CPS Programming Installation Guide (Motorola Solutions part number RVN5224_) for installation and setup procedures for the software.

Prerequisites: To perform the alignment procedures, the radio must be connected to the computer and to a universal test set, as shown in the following figure.

Figure 52: Radio Alignment Test Setup for Mobile Radios

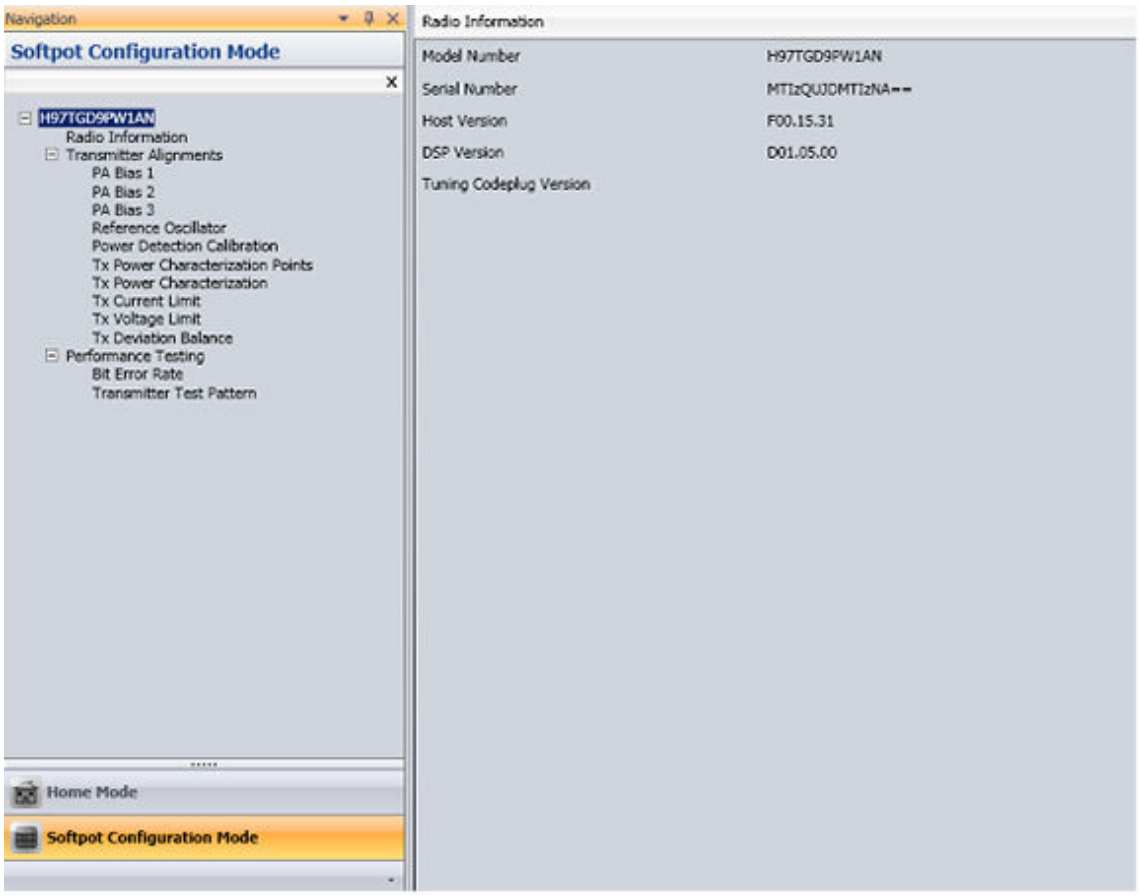


CAUTION: Only qualified service personnel who are operating as an FCC licensed technician or are overseen by an FCC licensed technician can perform the radio alignment procedures. Failure to perform alignment procedures properly may result in seriously degraded radio or system performance.

Procedure:

1. From the **Start** menu, select **Tuner**.
2. Click the **Read Device** icon to read the radio.
3. Click on the desired screen name in the **Tuner Main Menu** to access a screen.

Figure 53: VHF/700-800 MHz Tuner Main Menu



CAUTION: Do not switch radios in the middle of any alignment procedure.

4 After completing the alignment procedures, close the **Alignment** window to return to the **Tuner Main Menu**.

Improper exits from the **Alignment** screens might leave the radio in an improperly configured state and result in seriously degraded radio or system performance.

The **Alignment** screens utilize the “softpot”, an analog **SOFT**ware-controlled **POT**entiometer used for adjusting all radio alignment controls.

Use one of the following methods to increase or decrease the softpot value in each **Alignment** screen:

- Slider
- Spin buttons
- Manually enter a new value

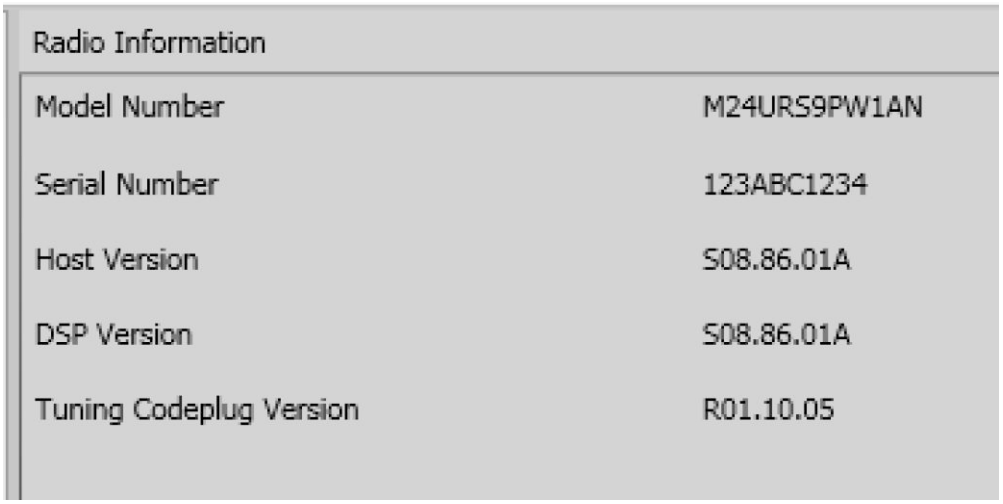
A graphical scale on the display indicates the minimum, maximum, and proposed value of the softpot.

6.2 Radio Information

Figure 54: Radio Information Screen on page 143 shows a typical Radio Information screen. All of the data appearing here is informational and cannot be changed.

NOTE: APX 2500/4500/4500Li/1500 VHF band do not support 100 W.

Figure 54: Radio Information Screen



6.3 Transmitter Alignments

This section covers the transmitter alignment. The PA Bias 1, 2, and 3 alignment procedures adjust the drain bias current in one of the RF power amplifier devices.

NOTE: Screen captures are representative. Actual screen may change with software version.

6.3.1 Aligning PA Bias 1

Prerequisites:

Table 42: PA Bias 1 Alignment RF Power Amplifier Devices

Band/Power Level	Device
VHF 50/25 W	Final
VHF 100 W	Final 1
UHF R1 40/25 W	Final 1
UHF R1 100 W	Final 1
UHF R2 45/25 W	Final 1
700–800 MHz 35 W	Final 1

Band/Power Level	Device
900 MHz 30 W	Final 1

NOTE: The appropriate antenna port should be terminated with a 50 Ω load while tuning.

Procedure:

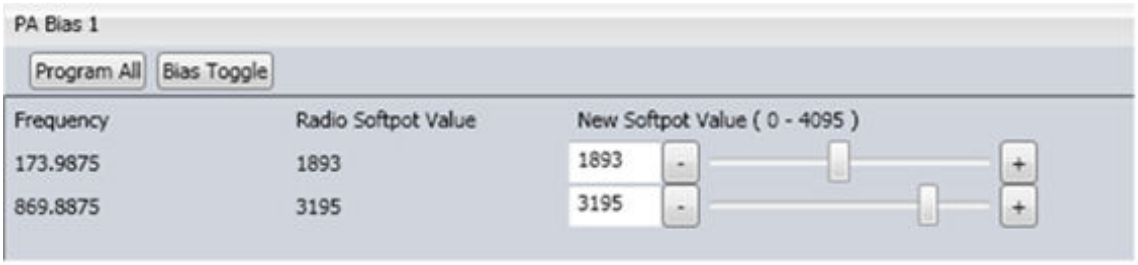
1 Set the power supply voltage as indicated in the following table. Set the power supply current limit to 3 A.

Table 43: Power Supply Voltage Settings

Band/Power Level	Supply Voltage (V)	Supply Current Limit (A)
VHF 50/25 W	13.6	3
VHF 100 W	13.4	3
UHF R1 40/25 W	13.6	3
UHF R1 100 W	13.4	3
UHF R2 45/25 W	13.6	3
700–800 MHz 35 W	13.6	3
900 MHz 30 W	13.6	3

2 Select **PA Bias 1** from the **Tuner Main Menu**.

Figure 55: PA Bias 1 Alignment Screen



When the screen is displayed, the radio enters a special bias tune mode, and radio current increases by approximately 70 mA.

3 Read the baseline current from the current meter on the power supply.

4 Add baseline current to device bias current to calculate the target current.

Table 44: PA Bias 1 Alignment Device Bias Current

Band/Power Level	Device Bias Current (mA)
VHF 50/25 W	400
VHF 100 W	75
UHF R1 40/25 W	30
UHF R1 100 W	500
UHF R2 45/25 W	200
700–800 MHz 35 W	250

Band/Power Level	Device Bias Current (mA)
900 MHz 30 W	250

5 Click **Bias Toggle** to apply bias to gate of device.

6 Adjust the softpot value until the target current is achieved within ±10%.

7 Click **Bias Toggle** to remove bias from gate of device.

8 Click **Program All** to save the tuned value.

9 Close the screen to return to the Tuner Main Menu.

6.3.2
Aligning PA Bias 2

Prerequisites:

Table 45: PA Bias 2 Alignment Amplifier Devices

Band/Power Level	Device
VHF 50/25 W	Driver
VHF 100 W	Final 2
UHF R1 40/25 W	Final 2
UHF R1 100 W	Final 2
UHF R2 45/25 W	Final 2
700–800 MHz 35 W	Final 2
900 MHz 30 W	Final 2

NOTE: The appropriate antenna port should be terminated with a 50 Ω load while tuning.

Procedure:

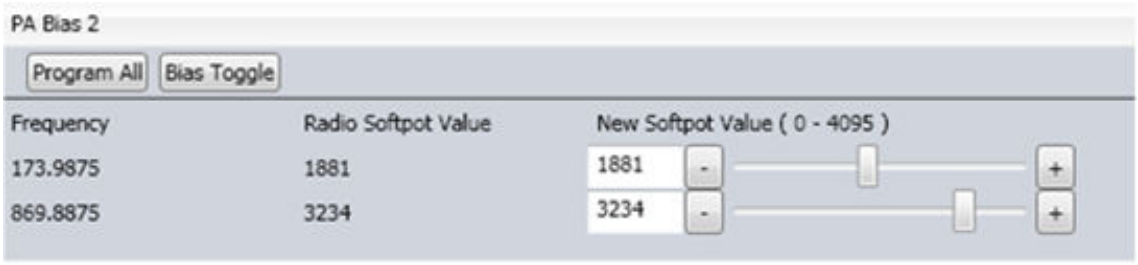
1 Set the power supply voltage as indicated in the following table. Set the power supply current limit to 3 A.

Table 46: Power Supply Voltage Settings

Band/Power Level	Supply Voltage (V)	Supply Current Limit (A)
VHF 50/25 W	13.6	3
VHF 100 W	13.4	3
UHF R1 40/25 W	13.6	3
UHF R1 100 W	13.4	3
UHF R2 45/25 W	13.6	3
700–800 MHz 35 W	13.6	3
900 MHz 30 W	13.6	3

2 Select **PA Bias 2** from the **Tuner Main Menu**.

Figure 56: PA Bias 2 Alignment Screen



When the screen is displayed, the radio enters a special bias tune mode, and the radio current increases by approximately 70 mA.

3 Read the baseline current from the current meter on the power supply.

4 Add baseline current to device bias current to calculate the target current.

Table 47: PA Bias 2 Alignment Device Bias Current

Band/Power Level	Device Bias Current (mA)
VHF 50/25 W	150
VHF 100 W	75
UHF R1 40/25 W	30
UHF R1 100 W	500
UHF R2 45/25 W	200
700–800 MHz 35W	250
900 MHz 30 W	250

5 Click **Bias Toggle** to apply bias to gate of device.

6 Adjust the softpot value until the target current is achieved within ±10%.

7 Click **Bias Toggle** to remove bias from gate of device.

8 Click **Program All** to save the tuned value.

9 Close the screen to return to the Tuner Main Menu.

6.3.3
Aligning PA Bias 3

Prerequisites:

Table 48: PA Bias 3 Alignment Amplifier Devices

Band/Power Level	Device
VHF 50/25 W	N/A
VHF 100 W	Driver
UHF R1 40/25 W	Driver
UHF R1 100 W	Driver
UHF R2 45/25 W	Driver
700–800 MHz 35 W	Driver

Band/Power Level	Device
900 MHz 30 W	Driver

NOTE: The appropriate antenna port should be terminated with a 50 Ω load while tuning.

Procedure:

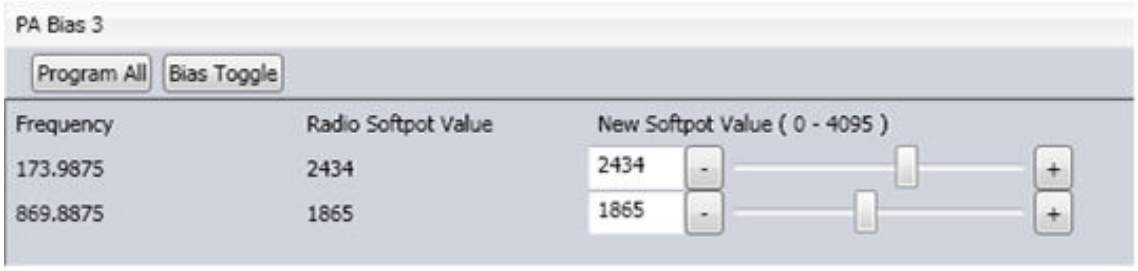
1 Set the power supply voltage as indicated in the following table. Set the power supply current limit to 3 A.

Table 49: Power Supply Voltage Settings

Band/Power Level	Supply Voltage (V)	Supply Current Limit (A)
VHF 50/25 W	NA	N/A
VHF 100 W	13.4	3
UHF R1 40/25 W	13.6	3
UHF R1 100 W	13.4	3
UHF R2 45/25 W	13.6	3
700–800 MHz 35 W	13.6	3
900 MHz 30 W	13.6	3

2 Select **PA Bias 3** from the **Tuner Main Menu**.

Figure 57: PA Bias 3 Alignment Screen



When the screen is displayed, the radio enters a special bias tune mode and the radio current increases by approximately 70 mA.

3 Read the baseline current from the current meter on the power supply.

4 Add baseline current to device bias current to calculate the target current.

Table 50: PA Bias 3 Alignment Device Bias Current

Band/Power Level	Device Bias Current (mA)
VHF 50/25 W	NA
VHF 100 W	150
UHF R1 40/25 W	150
UHF R1 100 W	150
UHF R2 45/25 W	100

Band/Power Level	Device Bias Current (mA)
700–800 MHz 35 W	100
900 MHz 30 W	100

5 Click **Bias Toggle** to apply bias to gate of device.

6 Adjust the softpot value until the target current is achieved within ±10%.

7 Click **Bias Toggle** to remove bias from gate of device.

8 Click **Program All** to save the tuned value.

9 Close the screen to return to the **Tuner Main Menu**.

6.3.4
Aligning the Reference Oscillator

Radios are shipped from the factory with a worst-case frequency error of ±250 Hz for the VHF frequency band, and ±600 Hz for the 700–800 MHz bands. These specifications are tighter than the more stringent FCC requirements of ±2.0 ppm for VHF and UHF, and ±1.5 ppm for the 700–800 MHz bands.

Prerequisites:
Radios that have been in storage for over six months from the factory ship date requires the reference oscillator to be checked when the radio is deployed to the field. Check the reference oscillator every time the radio is serviced or at least once a year, whichever comes first.

The crystal contained in the reference oscillator naturally drifts over time due to its aging characteristic. Periodic (annual) adjustment of the reference oscillator is important for proper radio operation.

Improper adjustment can result in both poor performance and interference with other users operating on adjacent channels.

This procedure should be done with an Aeroflex 3920 service monitor or an acceptable substitute

Procedure:

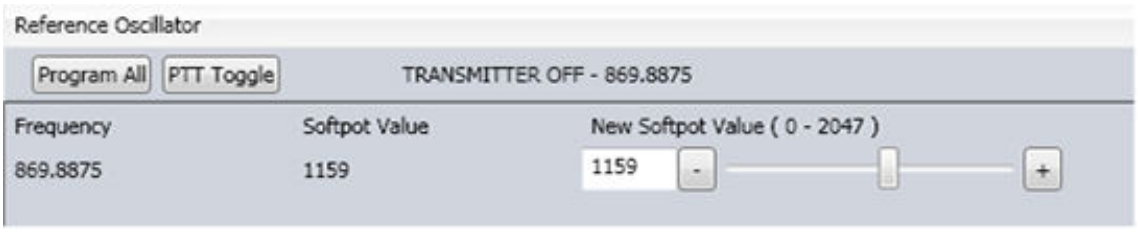
1 Initial setup using the Communication Analyzer:

Mode:	P25 Analog Mode 15 kHz LP filter enabled
RF Control:	P25 RX
Meter:	FM Deviation
Frequency:	Selected radio TX frequency

2 Connect a BNC cable between the “DEMOD OUT” port and the “Audio In 1” port on the service monitor.

3 Select **Reference Oscillator** from the **Tuner Main Menu**.

Figure 58: Reference Oscillator Window



4 Set the base frequency of the service monitor to the frequency displayed on the Tuner Main Menu.

5 For dual band radios, select the appropriate antenna port based on the frequency displayed in the **Tuner Main Menu** and connect it to the test equipment (see Figure 52: Radio Alignment Test Setup for Mobile Radios on page 141).

6 Click **PTT Toggle** to make the radio transmit.

The screen indicates whether the radio is transmitting.

7 Wait five seconds until the analyzer reading stabilizes, then record the transmitter frequency.

8 Adjust the reference oscillator softpot value until the measured value is as close as possible to the frequency shown on the screen. Allow approximately five seconds for the analyzer frequency reading to stabilize after each change.

Table 51: Reference Oscillator Alignment

Band	Target
VHF	±150 Hz
UHF	±150 Hz
800 MHz	±100 Hz
900 MHz	±100 Hz

9 Click **Program All** to dekey the radio and save the tuned values.

10 Close the screen to return to the **Tuner Main Menu**.

6.3.4.1
Setting Up the Communication Analyzer for Reference Oscillator Alignment

Procedure:

Set up the Communication Analyzer with values for the following parameters:

Table 52: Communication Analyzer Set up

Parameter	Value
RF Control	Analyzer or RX
B/W	WB
Freq	CPS frequency under test
Attenuation	20 dB (optional)
Mon RF In	RF I/O
Meter	Frequency Counter or Offset
Mode	Analog or P25 STD

6.3.5
Aligning the Power Detector Calibration

The power detector calibration alignment procedure adjusts the buffer gain for the forward power detector to minimize radio power variation from radio to radio.

Prerequisites: Terminate the appropriate antenna port with a calibrated power meter through a 30 db RF pad.

Procedure:

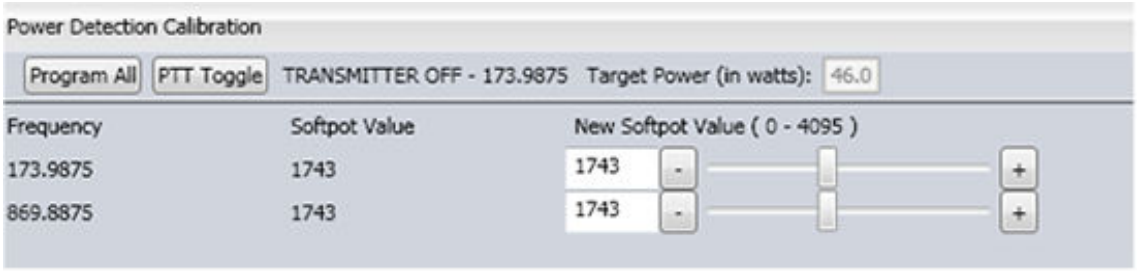
1 Set the power supply voltage and current limit as indicated in the following table.

Table 53: Power Supply Voltage Settings

Band/Power Level	Supply Voltage (V)	Supply Current Limit (A)
VHF 50/25 W	13.6	15
VHF 100 W	13.4	25
UHF R1 40/25 W	13.6	15
UHF R1 100 W	13.4	30
UHF R2 45/25 W	13.6	15
700–800 MHz 35 W	13.6	15
900 MHz 30 W	13.6	15

2 Select **Power Detection Calibration** from the **Tuner Main Menu**.

Figure 59: Power Detection Calibration Alignment Screen



3 Click **PTT Toggle** on the screen to make the radio transmit.

4 Adjust the softpot value until the target power is achieved.

5 Click **PTT Toggle** to disable transmit mode.

6 Click **Program All** to save the tuned value.

7 For dual band radio, switch antenna port and repeat the alignment procedure for the second frequency displayed in the tuning screen.

8 Close the screen to return to the **Tuner Main Menu**.

6.3.6
Aligning the Transmit Power Characterization

The Transmit (Tx) Power Characterization alignment procedure characterizes power tuning so that Tx power can be adjusted with the CPS software. The radio transmits at two power levels for each test frequency and you are required to record the measured power level with 0.1 W resolution.

Prerequisites: Terminate the appropriate antenna port with a calibrated power meter through a 30 db RF pad.

Procedure:

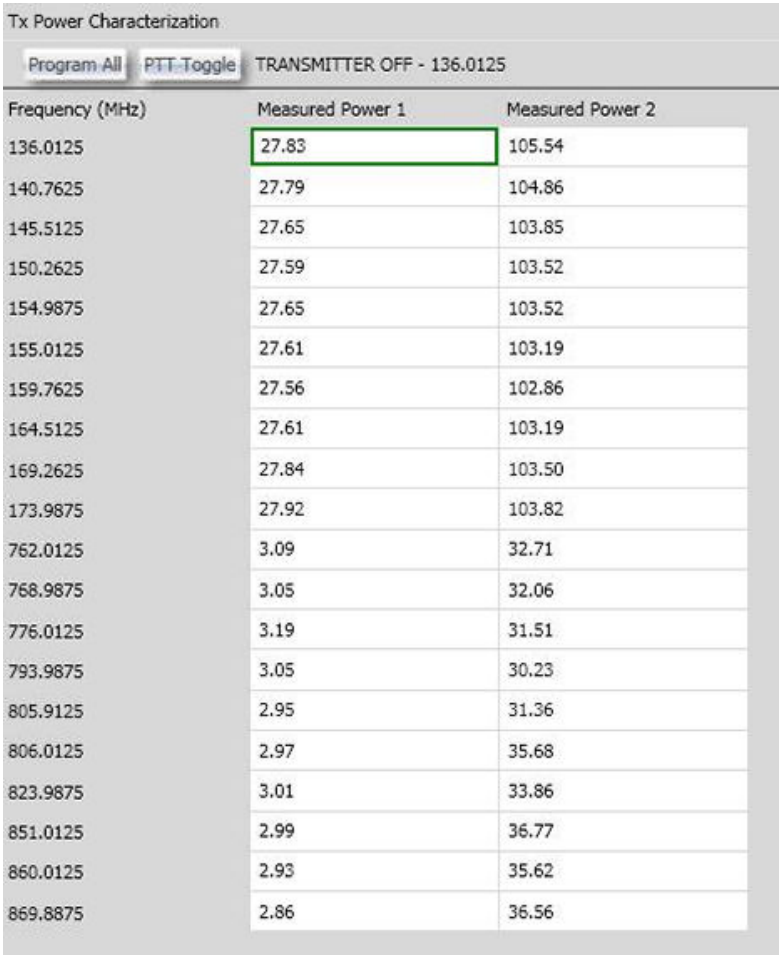
1 Set the power supply voltage and current limit as indicated in the following table.

Table 54: Power Supply Voltage Settings

Band/Power Level	Supply Voltage (V)	Supply Current Limit (A)
VHF 50/25 W	13.6	15
VHF 100 W	13.4	25
UHF R1 40/25 W	13.6	15
UHF R1 100 W	13.4	30
UHF R2 45/25 W	13.6	15
700–800 MHz 35 W	13.6	15
900 MHz 30 W	13.6	15

2 Select **Tx Power Characterization** from the **Tuner Main Menu**
.

Figure 60: Tx Power Characterization Alignment Screen



3 Click the first box of the Measured Power 1 column.

The perimeter of the box turns green indicating active characterization point.

4 Click **PTT Toggle** to transmit at the indicated frequency, then record the power measurement with 0.1 W resolution.

The perimeter of the box turns red, indicating that the radio is transmitting.

5 Click the **PTT Toggle** button to disable transmit mode.

6 Enter the power measurement with 0.1 W resolution, overwriting any value that may reside in the box from previous tuning.

7 Repeat step 3 through step 6 for Measured Power 2.

8 Repeat step 3 through step 7 for all frequencies.

9 Click **Program All** to save the tuned value.

10 Close the screen to return to the **Tuner Main Menu**.

6.3.7
Aligning the Transmit Current Limit

The Transmit (Tx) Current Limit alignment procedure tunes the Tx current-limiting protection.

Prerequisites: Terminate the appropriate antenna port with a calibrated power meter through a 30 db RF pad.

Procedure:

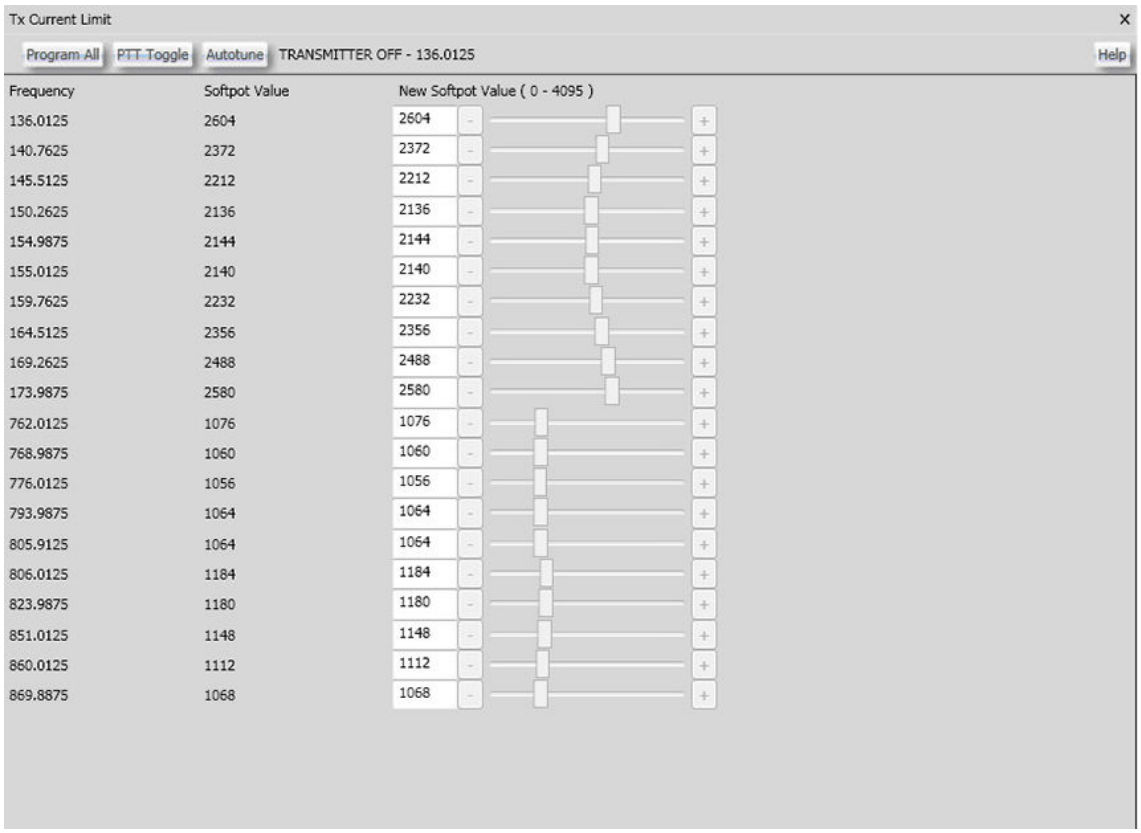
1 Set the power supply voltage and current limit as per the following table.

Table 55: Power Supply Voltage Settings

Band/Power Level	Supply Voltage (V)	Supply Current Limit (A)
VHF 50/25 W	13.6	15
VHF 100 W	13.4	25
UHF R1 40/25 W	13.6	15
UHF R1 100 W	13.4	30
UHF R2 45/25 W	13.6	15
700–800 MHz 35 W	13.6	15
900 MHz 30 W	13.6	15

2 Select **Tx Current Limit** from the **Tuner Main Menu**.

Figure 61: Tx Current Limit Alignment Screen



3 Select the first test frequency to tune.

4 Click **PTT Toggle** to transmit at the indicated frequency.

5 Click **Autotune**.

6 Repeat step 3 through step 5 for all test frequencies.

7 Click **Program All** to save the tuned values.

8 Close the screen to return to the **Tuner Main Menu**.

Table 56: Transmit Current Limit Devices

Band/Power Level	Devices		
VHF 50/25 W	Final		
VHF 100 W	Final 1	Final 2	Driver
UHF R1 40/25 W	Final 1	Final 2	Driver
UHF R1 100 W	Final 1	Final 2	Driver
UHF R2 45/25 W	Final 1	Final 2	Driver
700–800 MHz 35 W	Final 1	Final 2	Driver
900 MHz 30 W	Final 1	Final 2	Driver

6.3.7.1

Aligning the Transmit Voltage Limit

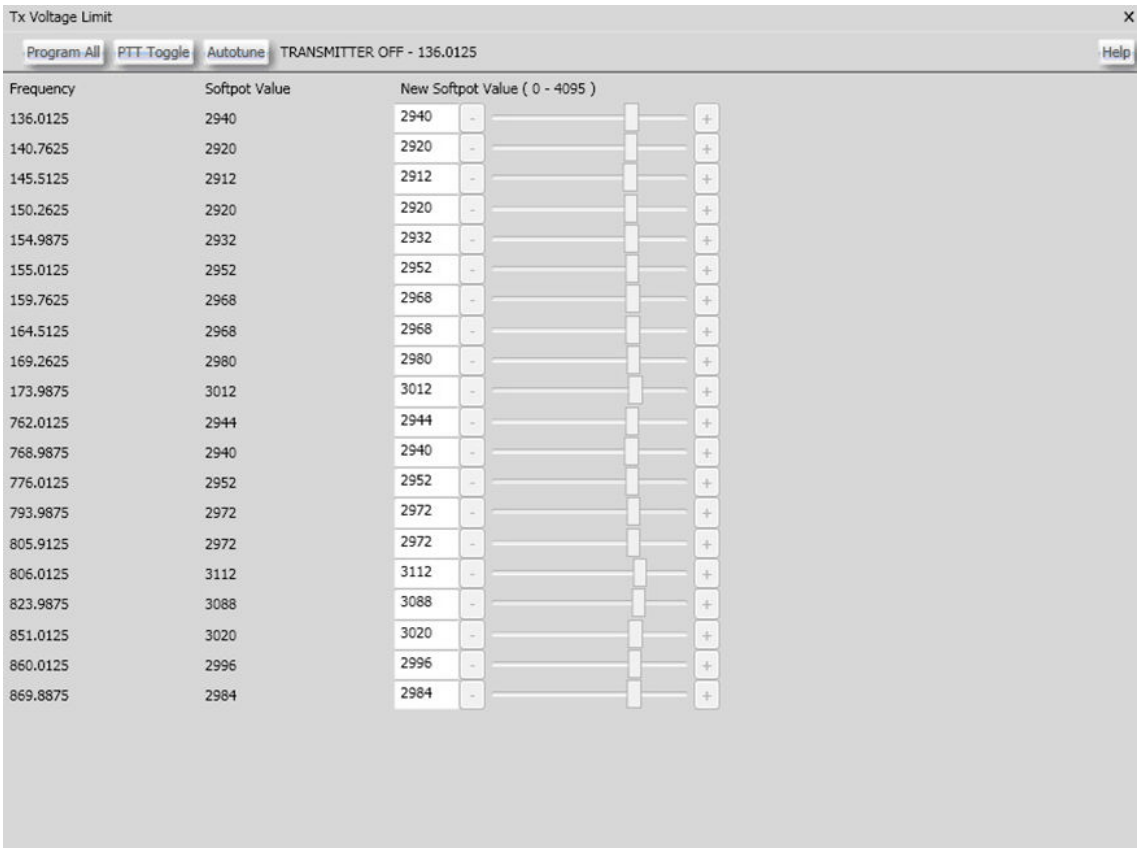
The Transmit (Tx) Voltage Limit alignment procedure tunes the Tx control voltage limiting protection.

Prerequisites: Terminate the appropriate antenna port with a calibrated power meter through a 30 db RF pad.

Procedure:

1. Set the power supply voltage and current limit as per the following table.
2. Select **Tx Voltage Limit** from the **Tuner Main Menu**.

   Figure 62: Tx Voltage Limit Alignment Screen



3. Select the first test frequency to tune.
4. Click **PTT Toggle** to transmit at the indicated frequency.
5. Click **Autotune**.
6. Repeat step 3 through step 5 for all test frequencies.
7. Click **Program All** to save the tuned values.
8. Close the screen to return to the **Tuner Main Menu**.

6.3.8
Tx Deviation Balance (Compensation)

The Tx Deviation Balance (Compensation) alignment procedure balances the modulation contributions of the low- and high-frequency portions of a baseband signal.

Prerequisites:

NOTE: This alignment is required after replacing (or servicing) components on the transceiver board.

Proper alignment is critical to the operation of signaling schemes that have very low frequency components such as DPL (Digital Private Line) and could result in distorted waveforms if improperly adjusted. The procedure needs to be performed at multiple frequencies to allow for proper alignment across the entire RF band. The RF band is divided into frequency zones with a calibration point (value) in each zone. When performing this tuning procedure, the PTT Tone Low generates an 300 Hz modulation frequency. The deviation level of this 300 Hz tone is used as the reference level for adjusting the deviation level of the PTT Tone High, which is a 3 kHz modulation frequency.

This procedure can be done with an Aeroflex 3920 service monitor or an acceptable substitute.

Procedure:

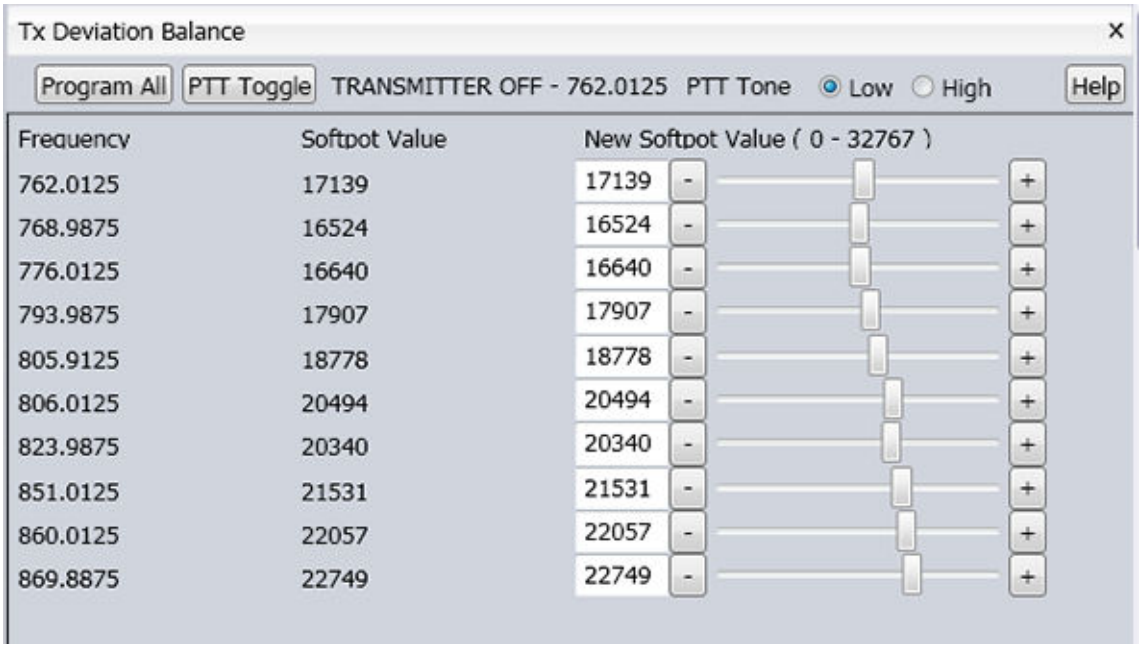
1 Initial setup using the Communication Analyzer:

Mode:	P25 Analog Mode 15 kHz LP filter enabled
RF Control:	P25 RX
Meter:	FM Deviation
Frequency:	Selected radio TX frequency

2 Connect a BNC cable between the “DEMOD OUT” port and the “Audio In 1” port on the service monitor.

3 Select **TX Deviation Balance (Compensation)** from the Tuner Main Menu. The screen indicates the transmit frequencies to be used. For dual band radios, select appropriate antenna port based on the frequencies displayed on the tuner screen and connect it to the test equipment. See Figure 52: Radio Alignment Test Setup for Mobile Radios on page 141.

Figure 63: Tx Deviation Balance (Compensation) Alignment Screen



4 Left-click the highest frequency field first.

5 Left-click the **PTT Tone Low** button.

6 Left-click the **PTT Toggle** button on the screen to enable transmission.

The screen indicates whether the radio is transmitting. Wait approximately 5 seconds until the voltage shown on the service monitor, stabilizes.

7 Measure and record the AC voltage or the deviation value from the service monitor.

8 Left-click the **PTT Tone High** button.

9 Adjust the softpot value until the measured deviation/voltage, when using the high tone, is within ±1% of the value observed when using the low tone.

10 Repeat step 5 through step 9 for the remaining frequencies.

11 Left-click the **Program All** button on the screen to dekey the radio and save the tuned values.

6.3.9
Performance Testing

This section covers the Bit Error Rate (BER) test and the transmitter test pattern.

6.3.9.1
Bit Error Rate (BER) Test

This procedure tests the Bit Error Rate (BER) of the radio receiver at a desired frequency.

Figure 64: Bit Error Rate Screen

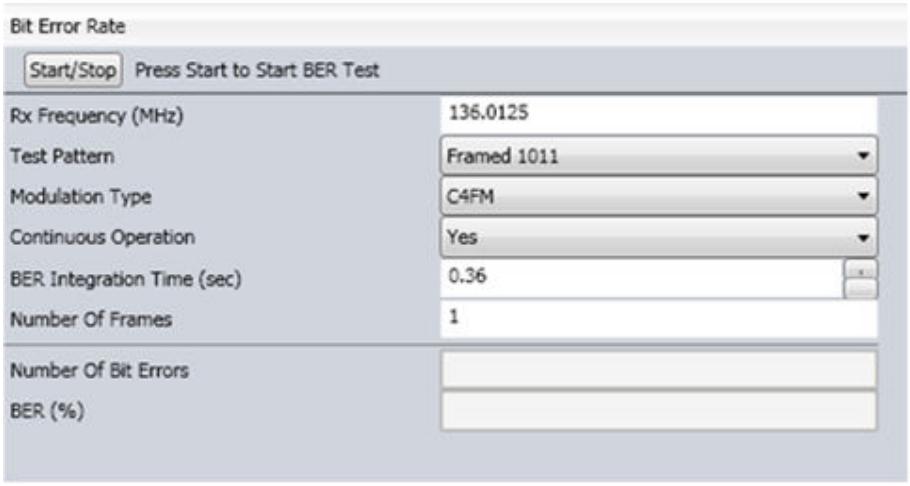


Table 57: Bit Error Rate Test Fields

Field	Description
Rx Frequency	Selects the Receive Frequency in MHz.
Test Pattern	Selects the Digital test pattern - TIA.
Modulation Type	Selects the digital modulation type of the incoming signal on which BER is to be calculated.
Continuous Operation	Allows the user to adjust the number of test repetitions. A selection of **Yes** causes the radio to calculate BER on a continuous basis indefinitely and update the results on this screen after each integration time. A selec-

Field	Description
	tion of **No** causes the BER test to execute only one sample and then update the display. **NOTE:** When Continuous Operation = **Yes**, all fields are dimmed while the test is in progress. They are enabled when the test is complete, or if the **STOP** button is pressed. When Continuous Operation = **No**, a wait cursor is displayed while the test is in progress and return to normal when the test is done.
Audio	Allows the user to select the audio output during a test. Selecting **External** routes the same signal to the radio accessory connector audio output. Selecting **Internal** is not supported. Selecting **Mute** disables the audio output.
BER Integration Time	Represents the amount of time during which the Bit Error Rate is to be calculated. Remember that integration over a longer time period results in a more precise measurement, at the expense of more time per measurement. **NOTE:** This is especially useful in fading measurements. The range is from 0.360 to 91.8 seconds in increments of 0.360 seconds.

6.3.9.2

Transmitter Test Pattern

This procedure allows you to generate test patterns at selectable frequencies and channel spacing to check the transmitter.

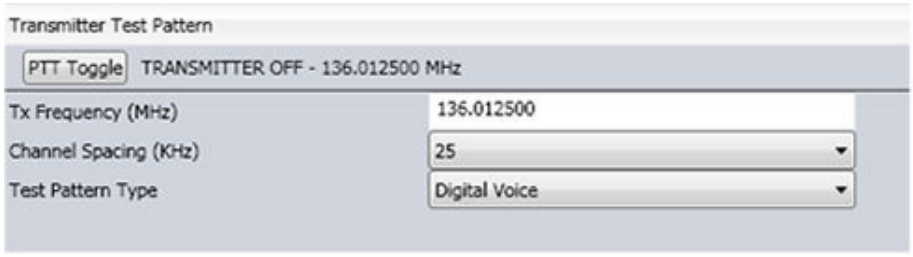
The procedure contains the fields described in the following table.

Table 58: Transmitter Test Pattern Fields

Field	Description
Tx Frequency	This field selects the Transmit Frequency directly in MHz.
Channel Spacing	This field allows you to select the desired transmit deviation in kHz.
Test Pattern Type	This field represents the type of test pattern that is transmitted by the radio when **PTT Toggle** is clicked.

NOTE: Test Pattern Type field is dimmed while the radio is transmitting.

Figure 65: Transmitter Test Pattern Screen



Chapter 7

Encryption

This chapter describes the encryption capability of your radio.

7.1 Motorola Advanced Crypto Engine Secure Options

NOTE: This information applies to both conventional and trunked systems.

The controller board contains the MACE (Motorola Advanced Crypto Engine) which can only be activated for secure-equipped APX mobile radios. These options can be found in the electronic catalog, ECAT. MACE uses a custom encryption IC and an encryption key variable to perform its encode or decode functions. The encryption key variable is loaded into the MACE using a key variable loader (KVL). The encryption IC corresponds to the particular encryption algorithm purchased.

7.1.1 Secure Key Retention

The APX 5500/6500/7500/6500Li comes standard with 30 second or infinite key retention (CPS setting). APX 2500 and APX 4500 do not support 3-days secure key retention, as there is no interface hardware.

If a 3 day key retention is required, the following option board kit is available:

Table 59: Secure Board Kit

Kit Number	Description
MHLN6999_S	Memory board with 3 day secure key retention

Table 60: Controller Boards with Programmed Secure Algorithms for APX 5500/6500/7500/6500Li

Kit Number	Description
NNTN7918_	Controller board, AES/DVP-XL encryption
NNTN7919_	Controller board, DVP-XL encryption
NNTN7920_	Controller board, AES/DES/DES-XL/DES-OFB encryption
NNTN7921_	Controller board, AES encryption
NNTN7922_	Controller board, DES/DES-XL/DES-OFB encryption
NNTN7923_	Controller board, ADP encryption

Table 61: Controller Boards with Programmed Secure Algorithms for APX 2500

Kit Number	Description
NNTN8425_	Controller board, AES encryption
NNTN8426_	Controller board, DES / DES-XL / DES-OFB encryption
NNTN8427_	Controller board, ADP encryption

Kit Number	Description
NNTN8428_	Controller board, DVP-XL encryption

Table 62: Controller Boards with Programmed Secure Algorithms for APX 4500

Kit Number	Description
NNTN8425_	Controller board, AES encryption
NNTN8427_	Controller board, ADP encryption

7.1.2
Securing Dispatch Operation

Procedure:

1 Press and release the **Secure** button to toggle between Secure and Clear for personalities or talkgroups that are programmed to be secure-selectable.

- An illuminated secure status annunciator indicates that the transmitted signal is encrypted when the **PTT** button is pressed.
- The absence of the secure status annunciator indicates that the transmitted signal is not going to be encrypted.

Whether the current personality is strapped for secure or clear, the secure status annunciator correctly displays the transmit operation as being either secure (encrypted) or clear (non-encrypted).

NOTE: You cannot change from secure to clear while the **PTT** button is pressed. The radio generates an illegal tone and the transmission is terminated.

Secure-equipped radios automatically determine whether a secure or clear voice message is being received. This allows you to receive either type of message without having to reset the programmable secure button.

7.1.3
Secure Emergency Operation

Clear or Secure emergency-call operation is determined by the selected mode, talkgroup, or the default emergency mode.

The transmit operation is controlled by the setting of the secure programmable button.

During an emergency call, you are not able to change from Secure to Clear, or from Clear to Secure operation.

7.2
Loading an Encryption Key

To load an encryption key into an APX mobile radio:

Procedure:

1 Ensure proper encryption algorithm has been flashed into the radio. (DES_XL, DES-OFB, AES256, and others)

2 Load an encryption key into the radio memory from a key-variable loader (KVL) using the correct loader for the radio encryption type.

3 Attach the keyloader cable to the control head MMP connector in the dash mount configuration and to the TIB MMP connector in the remote mount configuration.

`KEYLOADING` is displayed on the radio display while the key transfer is in progress.

For single-key radios, a short tone sounds when a key is successfully loaded.

For multi-key radios, an alternating tone sounds for a few seconds after keys are successfully loaded.

NOTE: An invalid encryption key aborts a secure transmission. Radio displays `KEYFAIL` and a keyfail tone (consecutive medium-pitched beeps) sounds until you release the **PTT** button.

4 If a mode is not programmed for either secure or clear-only operation, use the secure programmable button to select secure or clear transmission.

NOTE: You cannot change from secure to clear, or from clear to secure, while pressing the **PTT** button.

7.3 Advanced Secure Operation

NOTE: The Advanced Secure feature is available only on radios that have been equipped by the factory to support it.

Advanced Secure incorporates the Multikey feature and a dual-encryption feature into the existing secure system. Multikey allows a radio to be equipped with multiple encryption keys. A default key is included and is associated with the current mode. The keys are strapped to a given mode or are operator-selectable and can be indexed into groups of keys called keysets. The keys are loaded using a manual keyloader.

In addition, your radio can support up to eight different encryption algorithms simultaneously.

7.3.1 Multikey Operation

Multikey applies for conventional and trunking.

Conventional

The encryption keys can be selectively strapped in each channel. Encryption keys are loaded into the radio through a KVL. The programmable radio features include operator-selectable keys, indices, and key erasure.

Trunking

Strap the encryption keys for trunking on a talkgroup or announcement group if the radio also uses conventional features. A different encryption key can be strapped to other features:

- Private Call
- Dynamic Regrouping
- Failsoft
- Interconnect
- System Wide
- Emergency talkgroup

7.4 Erasing Keys

NOTE: The user navigation in this section might be different for every control head. Please refer to the respective control head user guide. .

Procedure:

1. Press the menu button labeled ERAS. Alternatively, press and hold the menu button labeled SEC until a tone sounds. Then press ERAS on the second menu that is displayed.
2. Use the **NAV** key to scroll through the encryption keys until the key to be erased is displayed. Alternatively, if a keypad microphone is used, press the numeric keys to jump to the desired encryption key.
3. Press the menu button labeled SNGL to erase the selected key.
4. Press the menu button labeled YES.

   The selected key is set to zero.

   ERASED is alternately displayed with the key name confirming the erasure.
5. To exit the menu without erasing a key, press the menu button labeled **ABRT**, the **PTT** button, or the **Home** button.

7.5 Erasing All Keys

NOTE: The user navigation in this section might be different for every control head. Please refer to the respective control head user guide. .

Procedure:

1. Press the menu button labeled ERAS. Alternatively, press and hold the menu button labeled SEC until a tone sounds. Then press ERAS on the second menu that is displayed.
2. Press the menu button labeled ALL.

   ERASE ALL KEYS is displayed.
3. Press the menu button labeled YES. All keys are erased.

   ERASED KEY is alternately displayed with the displayed key name confirming the erasure.
4. To exit the menu without erasing a key, press the menu button labeled **ABRT**, the **PTT** button, or the **Home** button.

7.6

Over-the-Air Rekeying

The Over-the-Air Rekeying (OTAR) feature allows the dispatcher to reprogram the encryption keys in the radio remotely.

NOTE: For more information, refer to the respective Control Head User Guide. .

Procedure:

1. Press the programmed **REKY** button.
2. Alternatively, press and hold the programmed **SEC** until a tone sounds.
3. Press the programmed **REKY** button.

   NOTE: Use the **NAV** key to scroll through the menus.

   `REQUEST REKEY` is displayed.
4. Press the **PTT** button to send the rekey request.

   `PLEASE WAIT` is displayed.

If the operation is successful, your radio shows one of the following indications:

- The radio sounds five tones when the dispatcher has received the request.

  NOTE: To exit the feature, perform one of the following actions:
  - Any subsequent press of the **PTT** button.
  - Press the **HOME** button.
  - Press the **Emergency** button.
- The display momentarily shows `REKEYED`.

If the operation is unsuccessful, your radio shows one of the following indications:

- The display momentarily shows `REKEY FAIL` and the bad-key tone sounds. This is because the radio does not contain the Unique Shadow Key (USK) or Unique Key Encryption Key (UKEK). You have to load the USK into the radio using the KVL before the radio can be reprogrammed over the air.

  NOTE: If you exit but stay on the current channel in the dispatch mode, your radio shows the following indications:
  - A tone sounds indicating the status of the rekey request.
  - The display shows `REKEYED` or `DENIED`.
- The display shows `NO ACK` and the bad-key tone sounds. Then, the dispatcher has not acknowledged your request after the radio has tried five times to send it. The radio returns to the display message in step 1, allowing you to retry the request.
- The display momentarily shows `DENIED` and the bad-key tone sounds. This means that the request has been denied by the dispatcher, and the radio returns to the home display.

Chapter 8

Disassembly/Reassembly Procedures

This section details the procedures necessary to remove and replace the printed circuit boards in APX mobile radios. After troubleshooting and determining what needs to be replaced, disconnect the test equipment, the antenna cable, and the power cable.

WARNING: Disconnect the power cable from the radio before opening and removing the PCB. Failure to remove power can result in unit damage caused by transients or accidental shorts, as well as presenting a shock hazard.
Locate the exploded view of the radio in Exploded Views and Parts Lists on page 339. Keep it handy for reference as you disassemble and reassemble the radio.

When installing a new circuit board, all mounting screws should be started before any are torqued. This will help ensure proper alignment.

After installing a new board, perform a complete alignment procedure as outlined in Radio Alignment Procedures on page 141.

8.1 Replacement Procedures

After performing alignment procedures, always exit the `SERVICE` menu entirely (to the `MAIN MENU`) to properly save all changes. Failure to do so can result in an alignment or other failure.

8.1.1 Required Tools and Supplies

Table 63: Required Tools and Supplies

Tools and Supplies	Motorola Solutions Part Number	Supplier Part Number
8 mm, 10 mm, 15 mm, 25 mm and 28 mm Hex Nut bits	–	–
Anti-static grounding kit	–	–
Flat-blade screwdriver	–	–
Long Nose Plier	–	–
Magnetic screwdriver set with bits	0180320B16	–
Mini-UHF to N-type adapter cable	3085651A01	–
Net Runner M8	–	–
Philips PH2 screw bit	–	–
Plastic scraping tool	6686119B01	–
Removal and insertion tool	6680163F01	–
Roto-Torq adjustable driver	–	RSX4043
Small, flat-blade screwdriver	–	–

Tools and Supplies	Motorola Solutions Part Number	Supplier Part Number
Solder aid (black stick), HEXACON	–	MA-800G
Tohnichi 6RTD-A Analog Torque Driver (1-6 in-lbs)	–	–
Torx T10 and T20 bits	–	–
Tweezers	–	–
Wire Stripper	–	–
Chassis Opener	6685666D01	–
O2/O7 Knob Removal Tool	66012035001	–
Electromagnetic Interference (EMI) metallic shielding tape, or equivalent	–	–

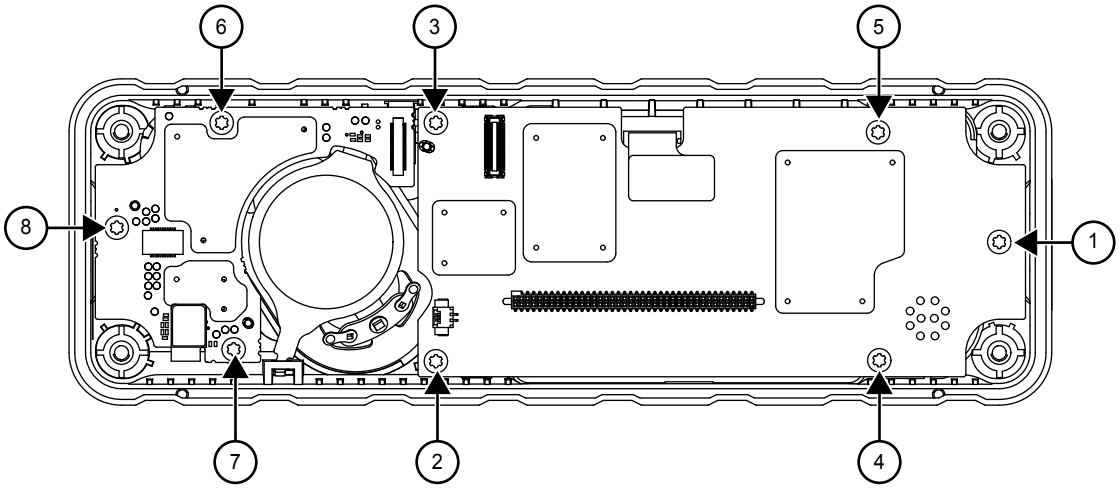
8.1.2
O2 Control Head Disassembly

NOTE: Bracketed numbers are identical to item numbers shown in Figure 319: O2 Control Head Exploded View on page 340.

Procedure:

1. Lay the control head face down on a clean, flat surface being careful not to scratch or mar the display.
2. Carefully disconnect the option board flex [17].
3. Using a Torx T10 screwdriver, remove the eight PCB screws [16] as shown in the following figure.

   Figure 66: PCB Screw Sequence



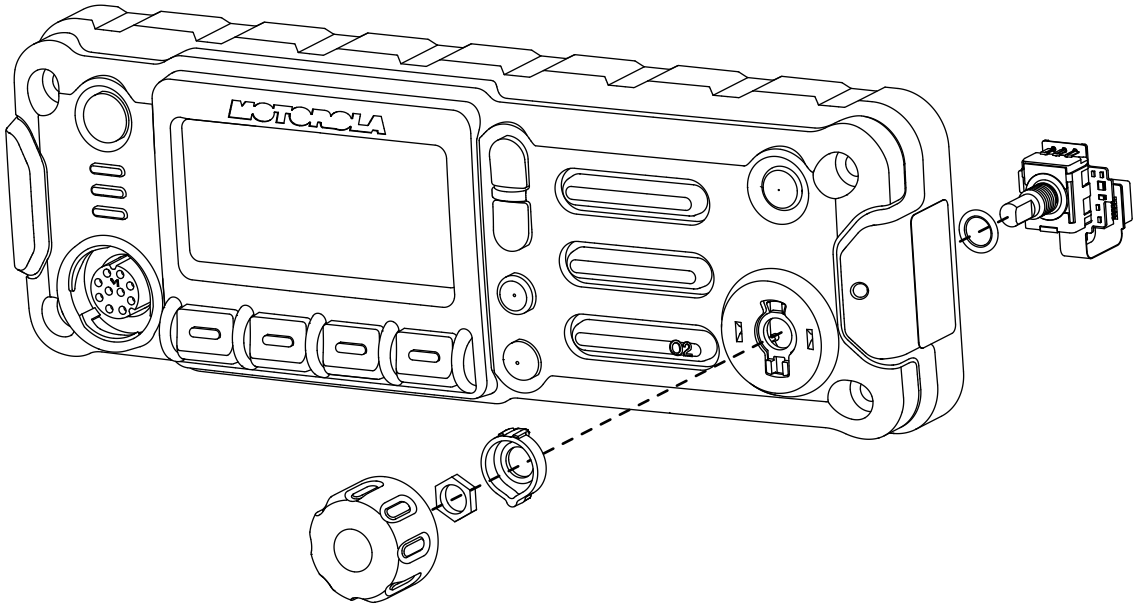
4. Carefully disconnect the speaker [21] connector assembly and the LCD display module [13] and encoder [23] flex assemblies.
5. After all the connectors have been unplugged, gently lift the option board PCB [18] and the main PCB [15] up from the front housing assembly.

   NOTE: Be careful not to damage the speaker connector or the LCD display module and encoder flex connectors when lifting up the main PCB and option board PCB.

6 Using the O2/O7 knob removal tool, remove the encoder knob [1] from the front housing assembly.

7 Using a hex nut driver, remove the encoder hex nut [2], followed by the detent spring [3], the encoder assembly [23], and o-ring [24] as shown in Figure 67: Removing The Encoder Assembly on page 166. Do not reuse the encoder hex nut.

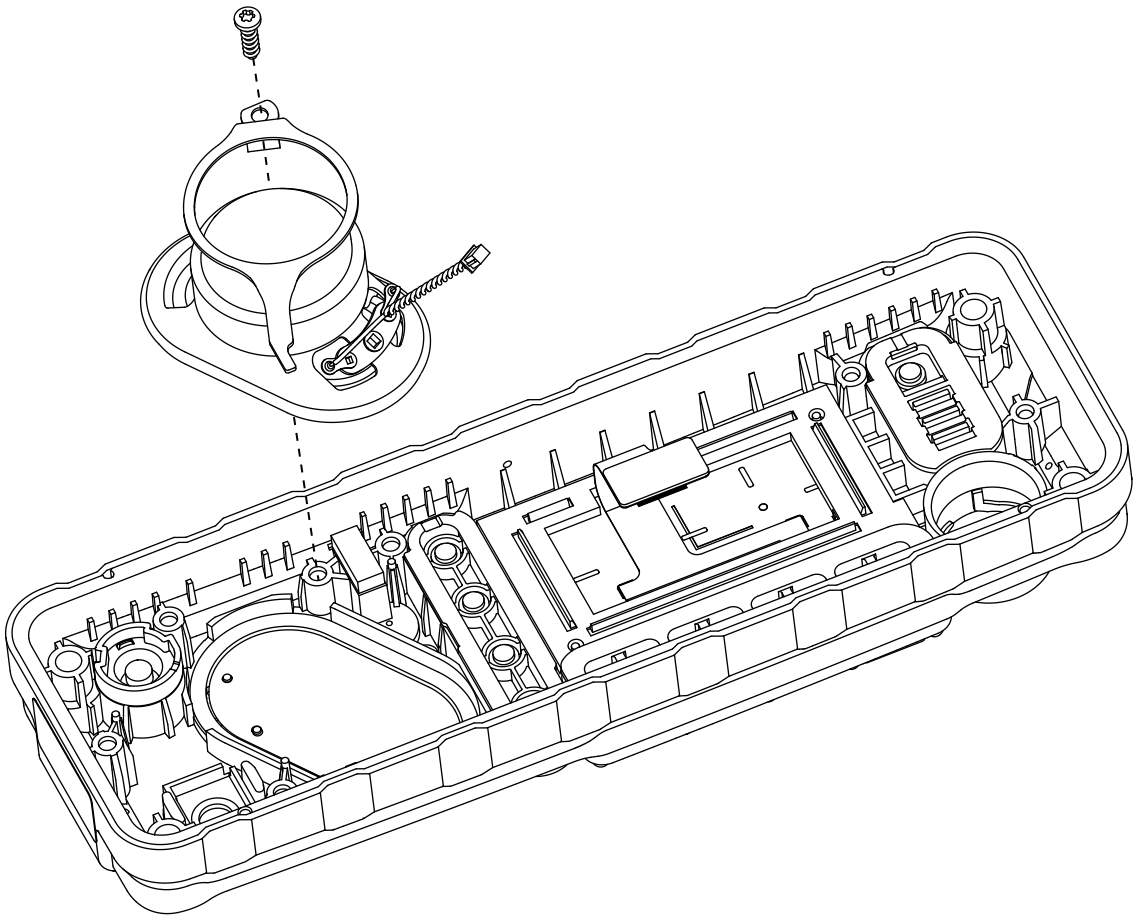
Figure 67: Removing The Encoder Assembly



8 Using a Torx T10 screwdriver, remove the speaker retention screw [19], followed by the speaker retainer [20] and speaker [21] as shown in Figure 68: Speaker Retainer Alignment on page 167.

NOTE: The speaker is affixed to front housing using an adhesive [22]. Once the speaker is removed, both the speaker and speaker adhesive must be replaced.

Figure 68: Speaker Retainer Alignment



8.1.3

O2 Control Head Reassembly

NOTE: Bracketed numbers are identical to item numbers shown in Figure 319: O2 Control Head Exploded View on page 340.

Procedure:

1. Apply a new speaker adhesive to the speaker recess on front housing.

   NOTE: Ensure all traces of previous speaker adhesive are removed, by thoroughly cleaning the speaker recess with IPA.

2. Based on the speaker wire orientation in Figure 68: Speaker Retainer Alignment on page 167, place a new speaker onto the adhesive.
3. Slot the speaker retainer into place and fasten the speaker retainer screw using a Torx T10 screwdriver (torque to 6 in.lbs.).
4. Insert the encoder assembly, o-ring, and detent spring into place and using a hex nut driver, fasten the new encoder hex nut (torque to 4.5 in.lbs.). See Figure 67: Removing The Encoder Assembly on page 166.
5. Press the knob firmly onto the shaft of the encoder assembly.

   NOTE: After the initial click of the encoder actuation, continue applying pressure to slide the knob smoothly into place.

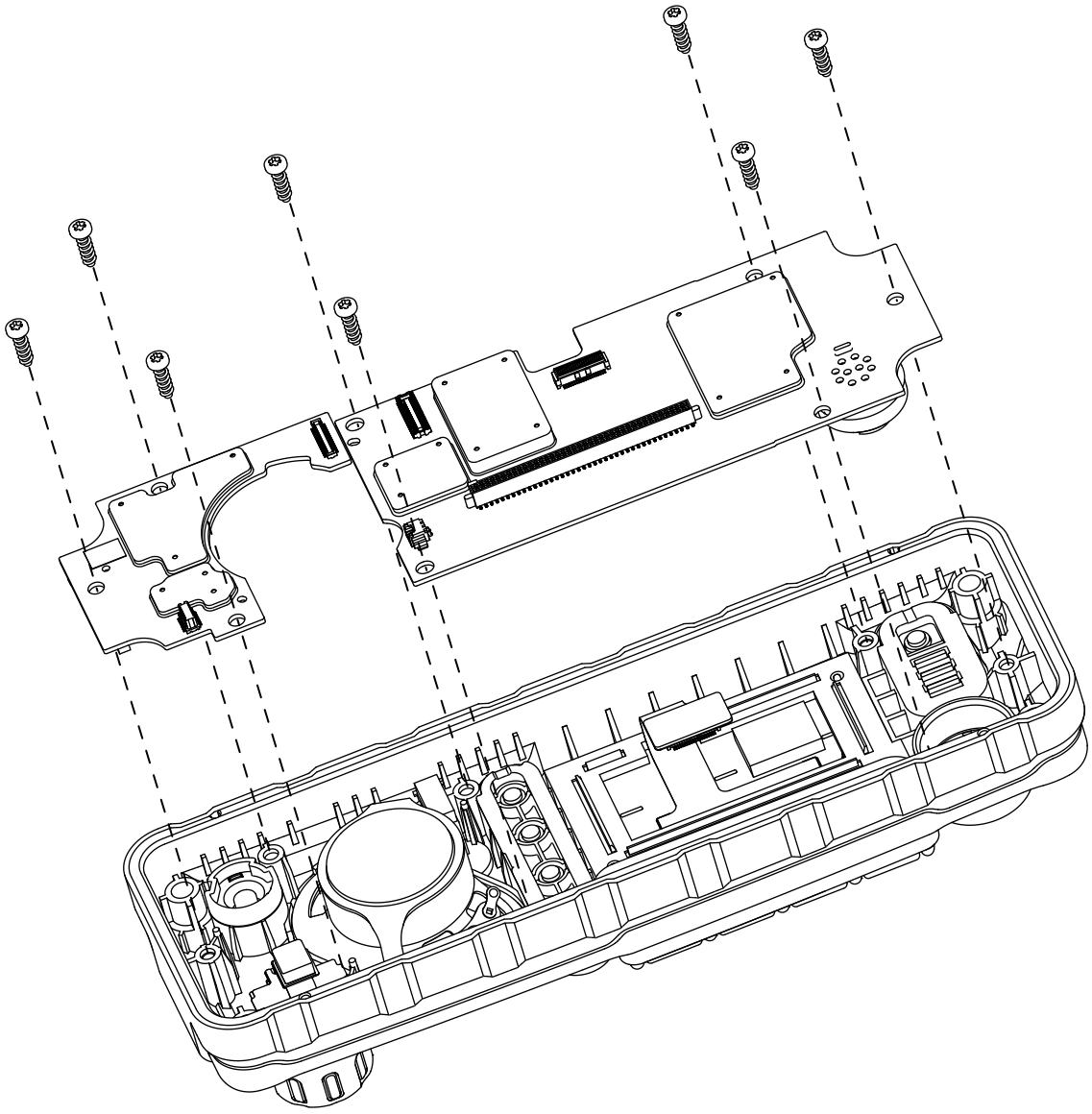
6 To reassemble the rest of the control head, ensure all the keypads are fully seated into front housing, and the LCD display module and encoder flex assemblies are not covered by either the main or option board PCB. Ensure that the GCAI seal [7] is properly placed on the GCAI connector.

7 Plug the speaker connector into the main PCB.

8 Place the main PCB into front housing, seating the PCB surface on the screw bosses. Ensure that the screw bosses align with the corresponding holes in the PCB. See Figure 69: PCB Screw Alignment on page 168.

NOTE: Be careful not to pinch the speaker connector wires or the LCD display module flex assembly when pushing the board in place.

Figure 69: PCB Screw Alignment



9 Using a Torx T10 screwdriver, fasten the first five PCB screws [16] following the sequence as shown in Figure 66: PCB Screw Sequence on page 165 (torque to 6 in. lbs.).

10 Plug in the LCD display module flex.

11 Plug the option board flex into the option board PCB, and insert the option board PCB into the front housing assembly. Ensure that the screw bosses align with the corresponding holes in the PCB.

NOTE: Be careful not to pinch the encoder flex assembly when pushing the board into place, and to align the board with the guide pin on the front housing assembly.

12 Plug the option board flex and encoder flex assembly into the main PCB.

13 Using a Torx T10 screwdriver, fasten the remaining three PCB screws following the sequence as shown in Figure 66: PCB Screw Sequence on page 165 (torque to 6 in. lbs.).

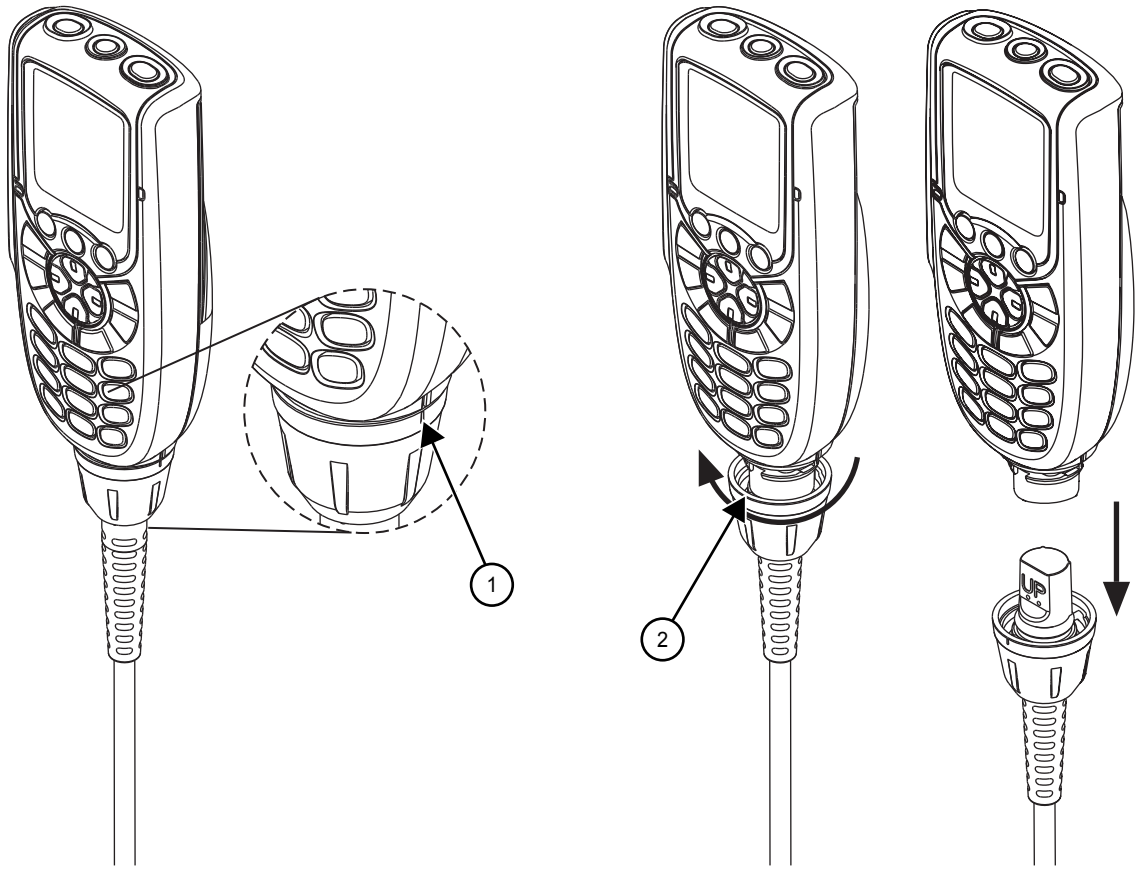
8.1.4
O3 Control Head Disassembly

NOTE: Bracketed numbers are identical to item numbers shown in Figure 320: O3 Control Head Exploded View on page 342.

Procedure:

1 Hold the control head straight up, and twist the cable lock as shown in the figure.

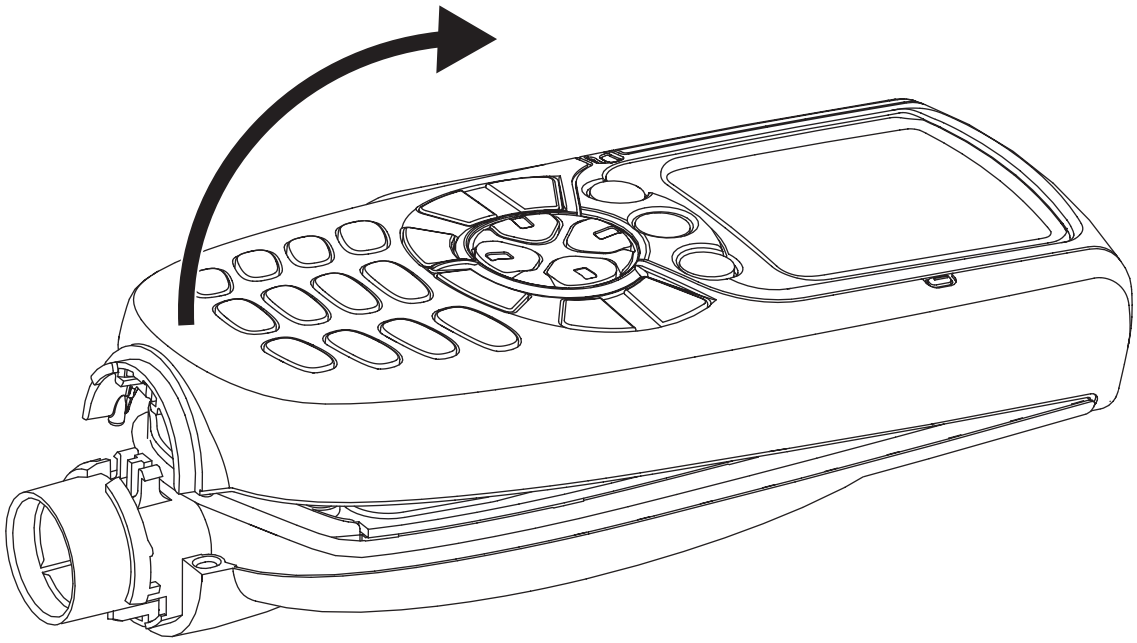
Figure 70: Cable Lock Detachment



1	“Marking” at LOCKED position
2	“Marking” at UNLOCKED position

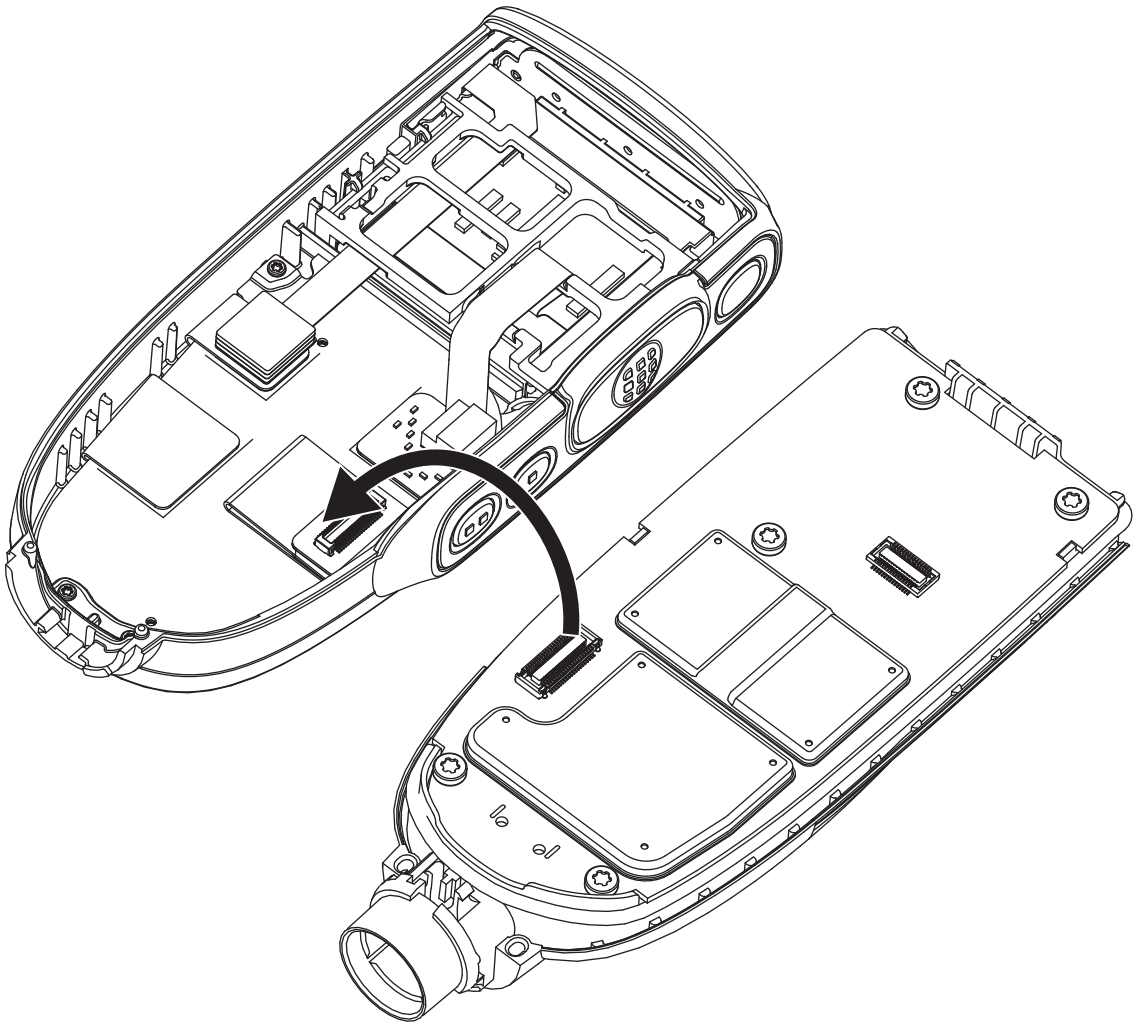
2 While holding the front housing, slowly pull the back housing from the cable insertion hole on the bottom until the two housings detached.

Figure 71: Front Housing and Back Housing Detachment



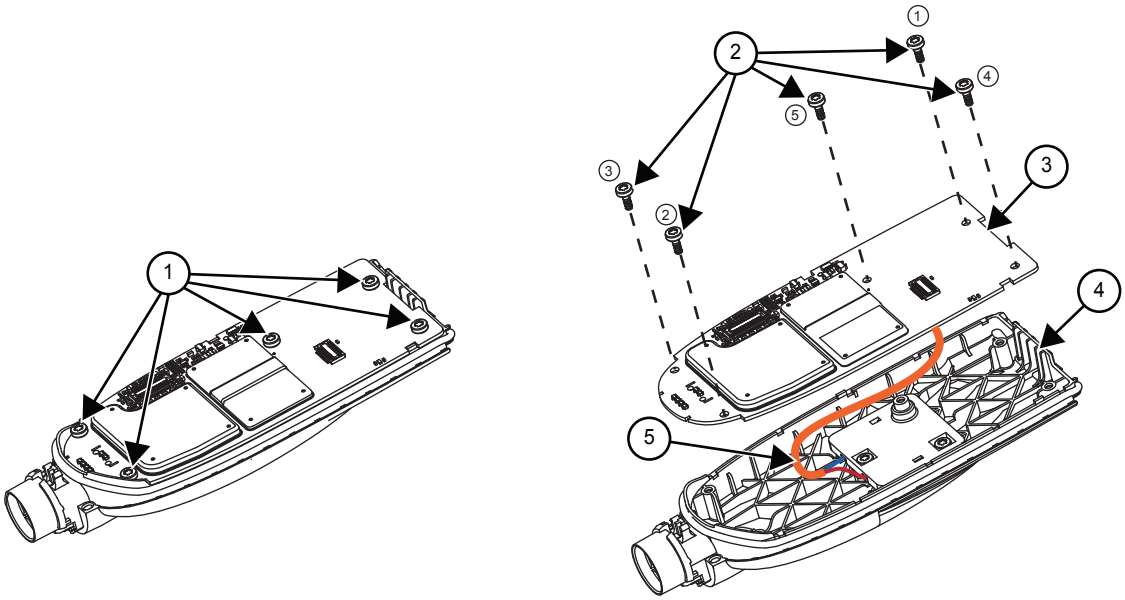
3 Disconnect the 40-pin connector and separate the front housing.

Figure 72: Separate Front Housing and Back Housing



4 Using a Torx T-8 screwdriver, remove the five printed circuit board (PCB) screws.

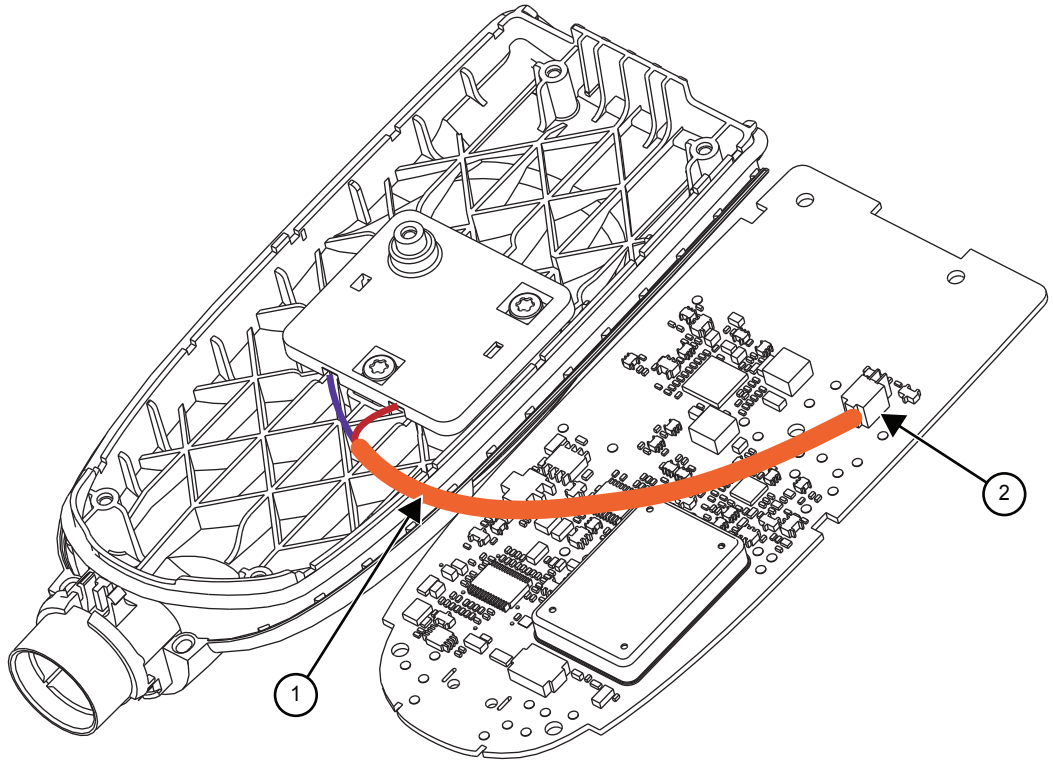
Figure 73: PCB Detachment



1 and 2	T-8 Screws
3	Main PCB Assembly
4	Back Housing
5	Hang-up stud connector wire

5 Gently pull out the 2-pin connector which connect the back housing to the PCB.

Figure 74: Disconnecting the 2-pin Connector



1	Hang-up stud connector wire
2	2-pin Connector

8.1.5

O3 Control Head Reassembly

NOTE: Bracketed numbers are identical to item numbers shown in Figure 320: O3 Control Head Exploded View on page 342.

Procedure:

1. To reassemble, ensure that the wire from the back housing is connected to the PCB and the o-ring seal is installed properly.
2. Place the PCB on the back housing as shown in the picture.
3. Using a Torx T-8 screwdriver, fasten the five PCB screws following the sequence as shown in Figure 73: PCB Detachment on page 172 (torqued to 4 in. lbs).
4. Plug in the 40-pin connector from Front Housing to the PCB. Make sure the connector is intact.
5. Put the Back Housing and Front Housing together.
6. Insert the coiled cable. Twist the cable lock to tighten the control head.

8.1.6

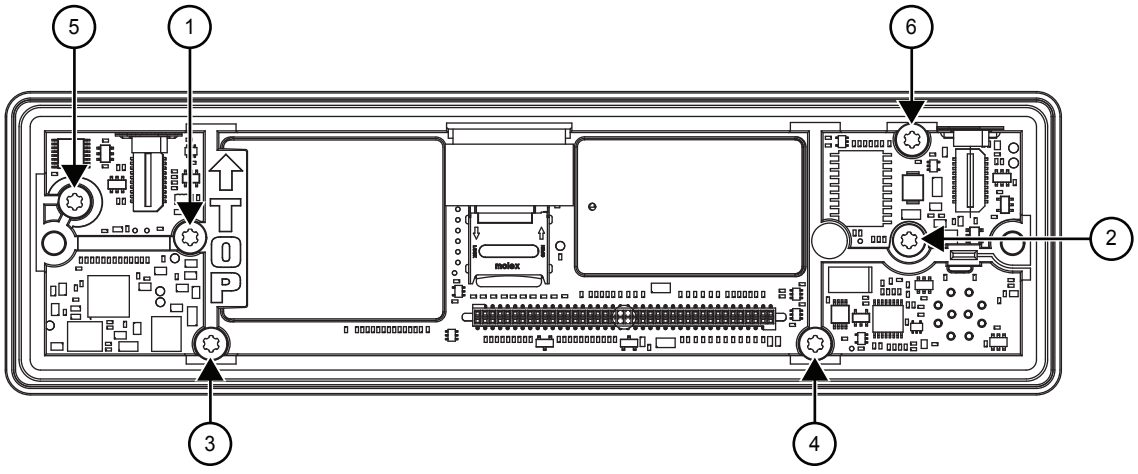
O5 Control Head Disassembly

NOTE: Bracketed numbers are identical to item numbers shown in Figure 321: O5 Control Head Exploded View on page 343.

Procedure:

1. Lay the control head face down on a clean, flat surface being careful not to scratch or mark the display.
2. Using a Torx T10 screwdriver, remove the 6 control head screws [14] as shown in Figure 75: Control Head Screw Sequence on page 173.

   Figure 75: Control Head Screw Sequence



3. Carefully separate the sealframe [13] from the front housing assembly [6].
4. Carefully disconnect the LCD module [10], volume flex assembly [7], and mode switch flex [17].

5 After all the connectors have been unplugged, gently lift up the control head board [12] from the front housing assembly [6].

NOTE: Be careful not to damage the LCD module, volume, and mode switch flex connector while lifting the control head board.

8.1.7
O5 Control Head Reassembly

NOTE: Bracketed numbers are identical to item numbers shown in Figure 321: O5 Control Head Exploded View on page 343.

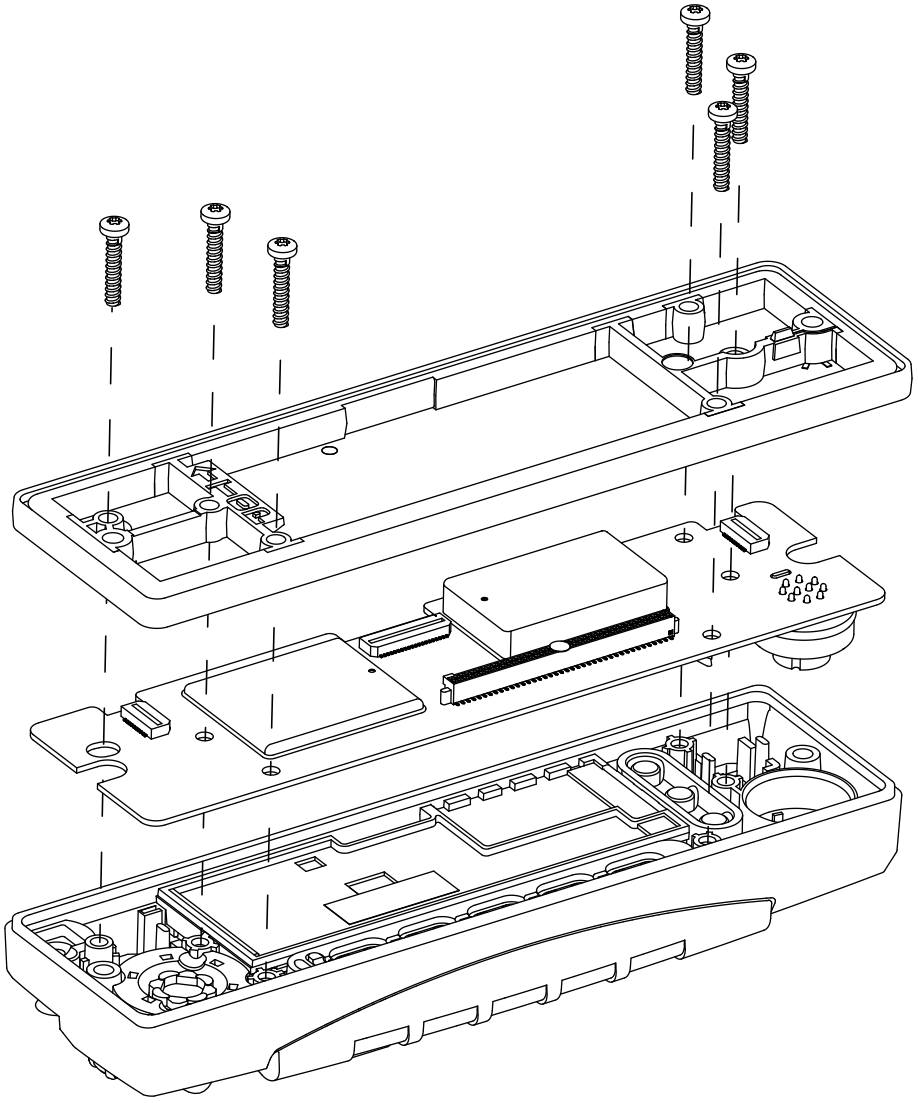
Procedure:

1 To reassemble, ensure that all the keypads are fully seated into the front housing, and that all the flexes (LCD Display module, volume and mode) will not be covered by the PCB. Ensure that the MMP seal is properly placed on the MMP connector.

2 Place the PCB in the housing seating the PCB surface to the screw bosses. Ensure that the aligning boss protrudes through the PCB. See Figure 76: Main PCB Screw Alignment on page 175.

NOTE: Be careful not to pinch the flex for the LCD module and the volume switch flex assembly while pushing the board in place.

Figure 76: Main PCB Screw Alignment



3 Plug in the three flexes.

4 Place the sealframe onto the PCB locating the “Top” is oriented correctly.

5 Using a Torx T10 screwdriver, fasten the 6 control head screws [14] following the sequence as shown in Figure 75: Control Head Screw Sequence on page 173 (torque to 8 in. lbs).

8.1.8

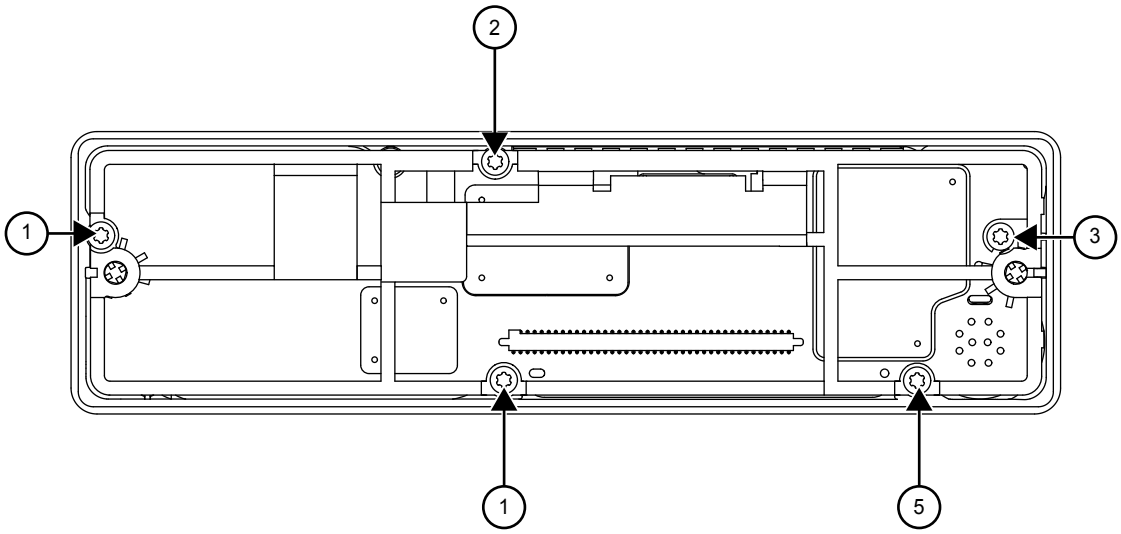
O7 Control Head Disassembly

NOTE: Bracketed numbers are identical to item numbers shown in Figure 322: O7 Control Head Exploded View on page 345.

Procedure:

1. Lay the control head face down on a clean, flat surface being careful not to scratch or mar the display.
2. Using a Torx T10 screwdriver, remove the five main PCB retention screws [15] as shown in the following figure.

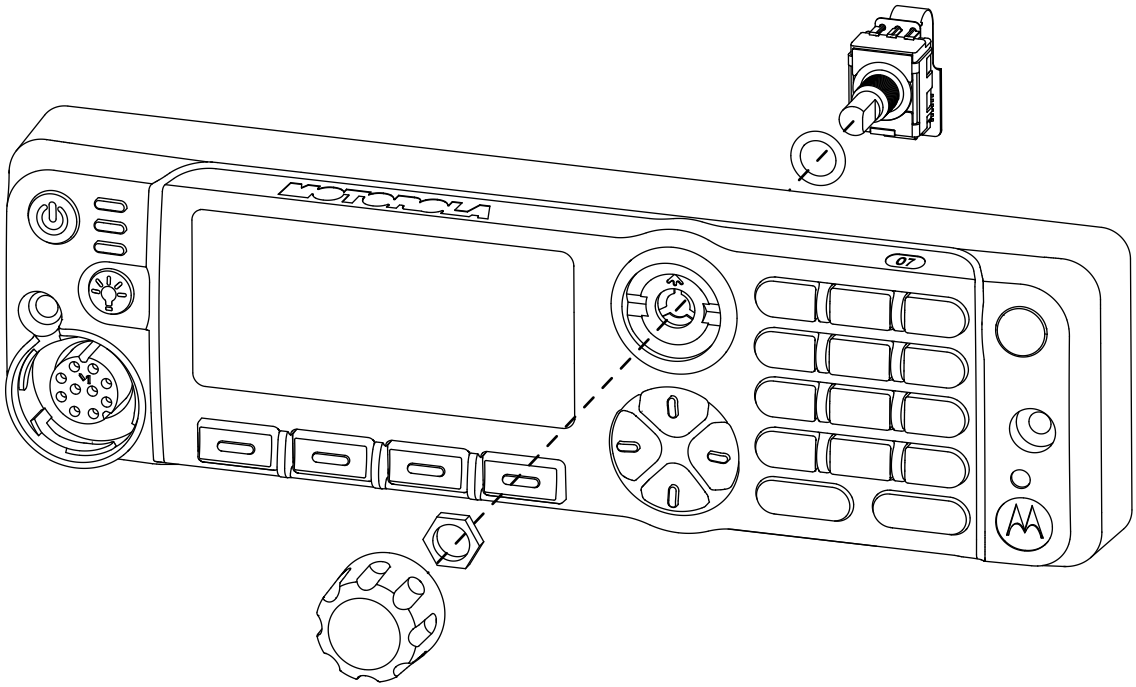
   Figure 77: Main PCB Retention Screw Sequence



3. Carefully separate the main PCB retainer [14] from the front housing assembly.
4. Carefully disconnect the Bluetooth [16], encoder [7] and LCD display module [11] flex assemblies. Disassemble the encoder [7] flex connector, by pulling in a normal direction to the PCB, in avoiding damage to the flex and connector.
5. After all the connectors have been unplugged, gently lift the main PCB [13] up from the front housing assembly.

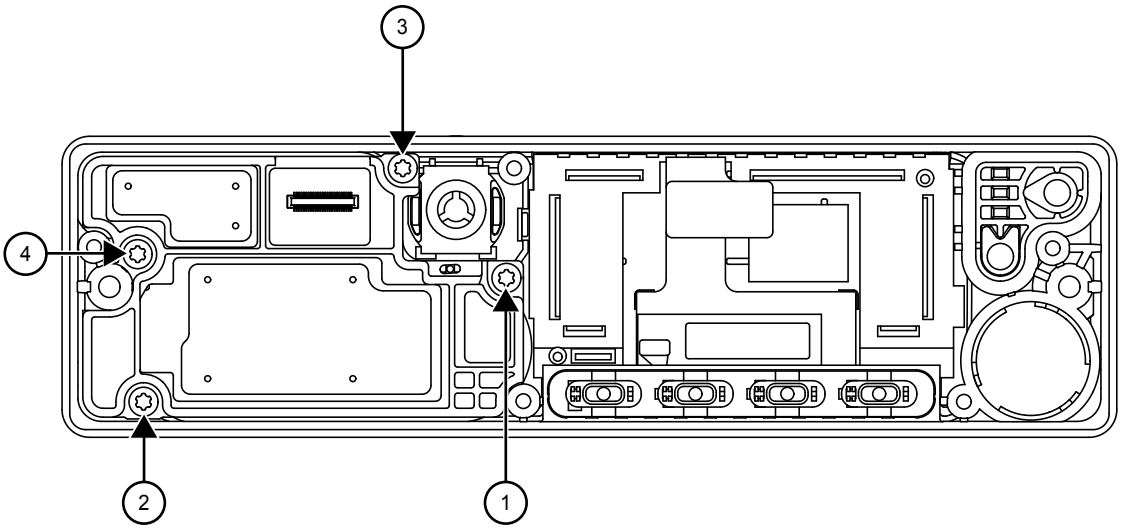
   NOTE: Be careful not to damage the Bluetooth, encoder or LCD display module flex connectors when lifting up the main PCB.
6. Carefully disconnect the Bluetooth flex from the Bluetooth PCB [19].
7. Using the O2/O7 knob removal tool, remove the encoder knob [1] from the front housing assembly.
8. Using a hex nut driver, remove the encoder hex nut [2], followed by the encoder assembly [7], and o-ring [6] as shown in Figure 78: Removing the Encoder Assembly on page 177. Do not reuse the encoder hex nut.

Figure 78: Removing the Encoder Assembly



9 Using a Torx T10 screwdriver, remove the four Bluetooth PCB retention screws [17] as shown in the following figure.

Figure 79: Bluetooth PCB Retention Screw Sequence



10 Carefully separate the Bluetooth PCB retainer [18] from the front housing assembly.

11 Gently lift the Bluetooth PCB up from the front housing assembly.

NOTE: Be careful not to damage the encoder flex connector when lifting up the Bluetooth PCB.

8.1.9

O7 Control Head Reassembly

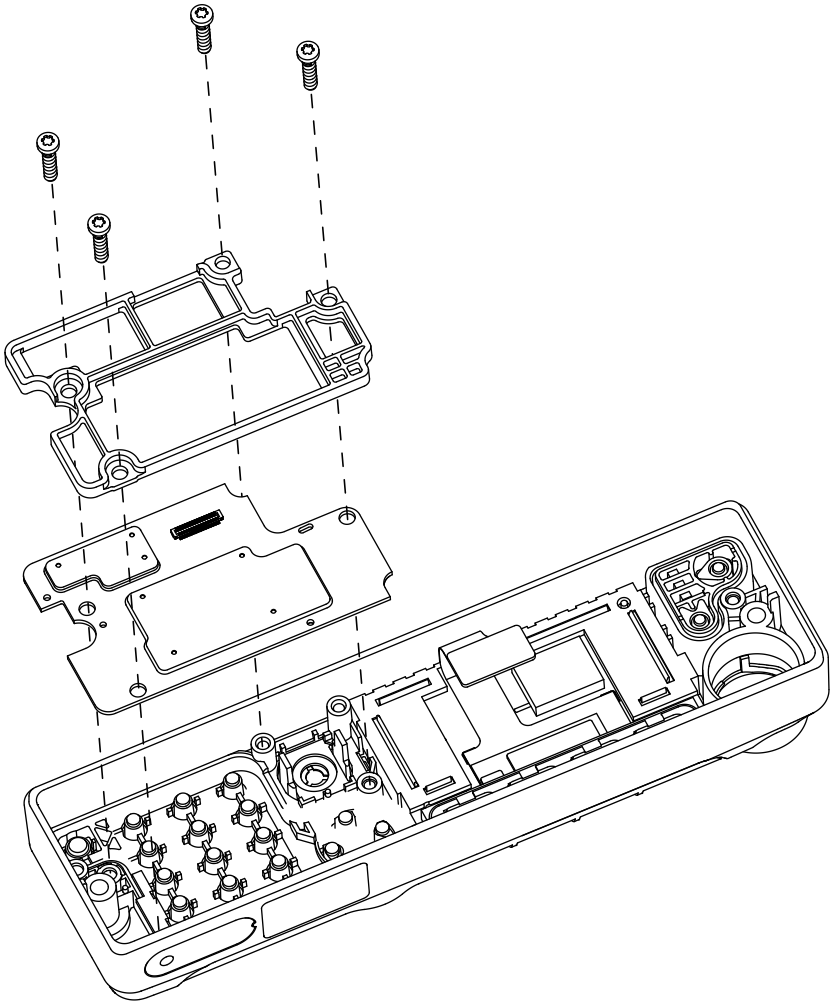
NOTE: Bracketed numbers are identical to item numbers shown in Figure 322: O7 Control Head Exploded View on page 345.

Procedure:

1. To reassemble, ensure that all the keypads are fully seated into the front housing, and that the LCD display module and encoder flex assemblies will not be covered by either the main or Bluetooth PCB. Ensure that the GCAI seal [5] is properly placed on the GCAI connector.
2. Place the Bluetooth PCB and Bluetooth PCB retainer in the front housing, seating the PCB surface on the screw bosses. Ensure that the screw bosses align with the corresponding holes in the PCB and retainer. See Figure 80: Bluetooth PCB Retention Screw Alignment on page 178.

   NOTE: Be careful not to pinch the flex for the encoder flex assembly when pushing the board and retainer in place.

   Figure 80: Bluetooth PCB Retention Screw Alignment



3. Using a Torx T10 screwdriver, fasten the four Bluetooth PCB retention screws following the sequence as shown in Figure 79: Bluetooth PCB Retention Screw Sequence on page 177 (torque to 6 in. lbs.).
4. Plug in the Bluetooth flex.

5 Insert the encoder assembly and o-ring into place and using a hex nut driver, fasten the new encoder hex nut (torque to 4.5 in. lbs.). See Figure 78: Removing the Encoder Assembly on page 177.

6 Press the knob firmly onto the shaft of the encoder assembly.

NOTE: After the initial click of the encoder actuation, continue applying pressure to slide the knob smoothly into place.

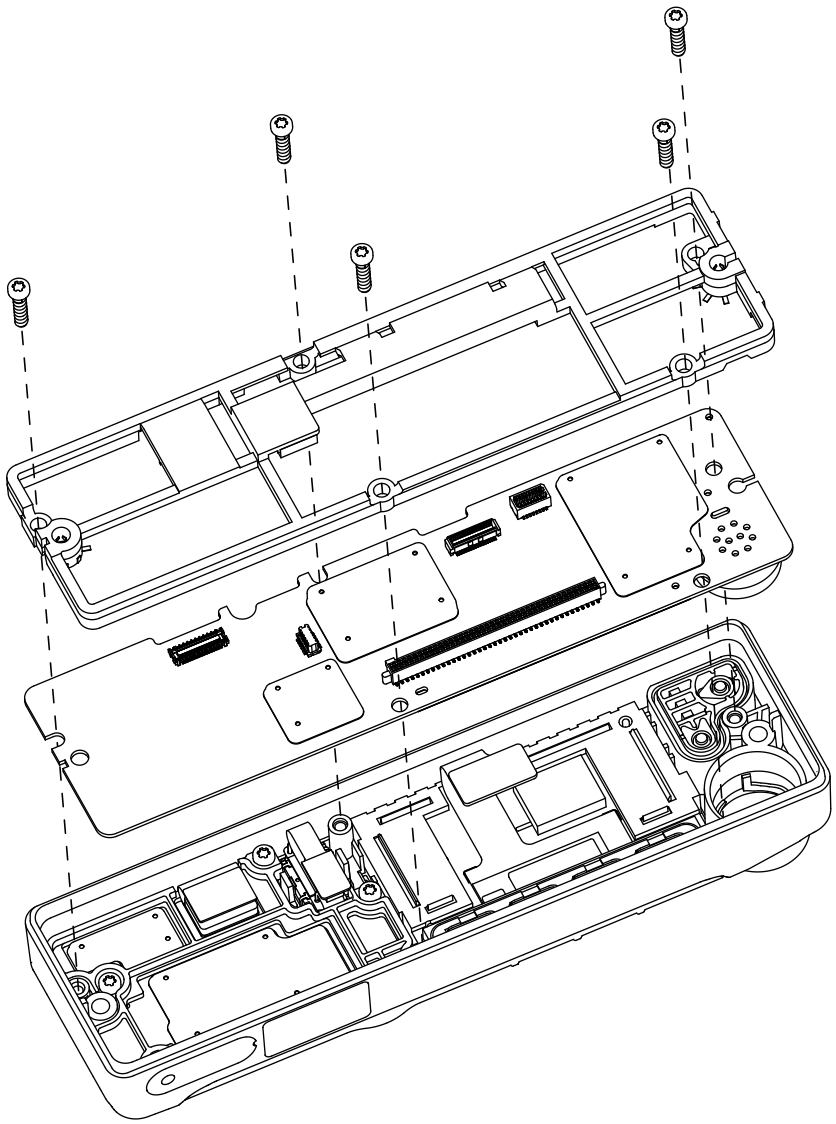
7 Place the main PCB in the front housing, seating the PCB surface on the screw bosses.

8 Plug in the Bluetooth, encoder, and LCD display module flexes.

9 Place the main PCB retainer in the front housing, and it all the way to the left to ensure the screw bosses align with the corresponding holes in PCB and retainer. See Figure 81: Main PCB Retention Screw Alignment on page 179.

NOTE: Be careful not to pinch the flexes for the Bluetooth, encoder or LCD display module flex assemblies when pushing the board and retainer in place.

Figure 81: Main PCB Retention Screw Alignment



10 Using a Torx T10 screwdriver, fasten the five PCB screws following the sequence as shown in Figure 77: Main PCB Retention Screw Sequence on page 176 (torque to 6 in. lbs.).

8.1.10
O9 Control Head Disassembly

NOTE: Bracketed numbers are identical to item numbers shown in Figure 323: O9 Control Head Exploded View on page 347.

Procedure:

1 Lay the control head faces up on a clean and flat surface, pull out the top pursuit knob [1] using long nose plier with cloth at the clamp area to avoid damaging the pursuit knob. The volume knob [6] and frequency knob [8] should be removed using a small, flat-blade screwdriver or chassis opener. Ensure that the three knobs are still with the D-clips inserts inside. Ensure the torque enhancers [7] for volume and frequency knobs are in the knobs.

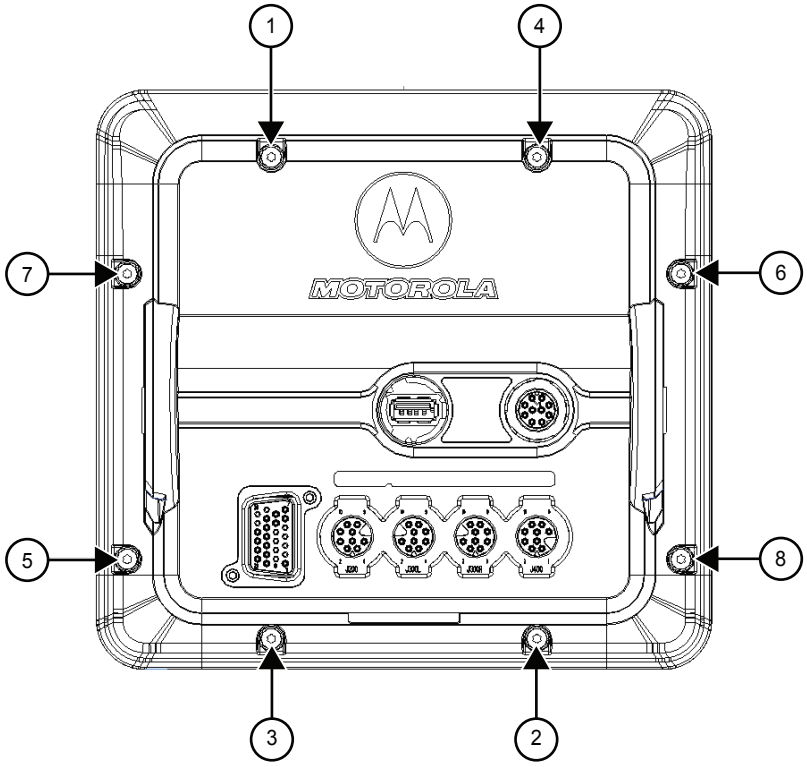
NOTE: Only disassemble the top pursuit knob if plan to replace top pursuit switch flex, top pursuit knob, top pursuit light bar keypad, top pursuit siren keypad, or top keypad PCB kit. Only disassemble the volume knob and frequency knob if plan to replace volume flex, frequency flex, volume knob and frequency knob.

2 Remove all the three nuts [2] with 8 mm Hex nut bits and then remove the washers [3] as well.

3 Then, remove the pursuit spring [4] from the top pursuit knob area.

4 Using a Torx T10 screwdriver, remove the 8 screw assemblies [44] as shown in the following figure.

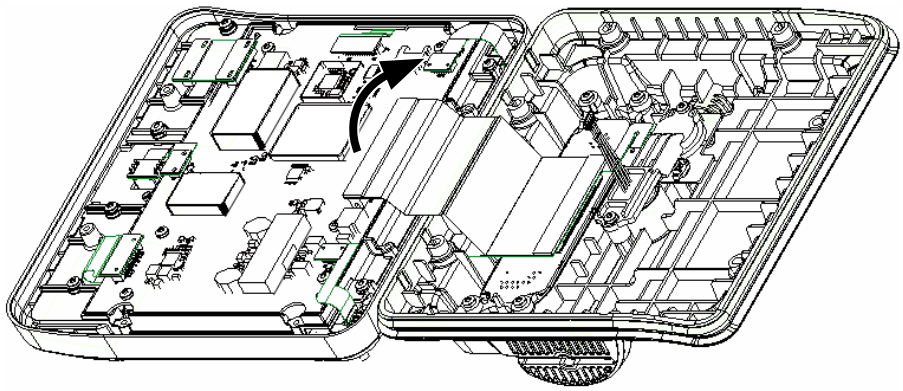
Figure 82: Control Head Screw Sequence



5 Carefully separate the back housing assembly from the front housing assembly.

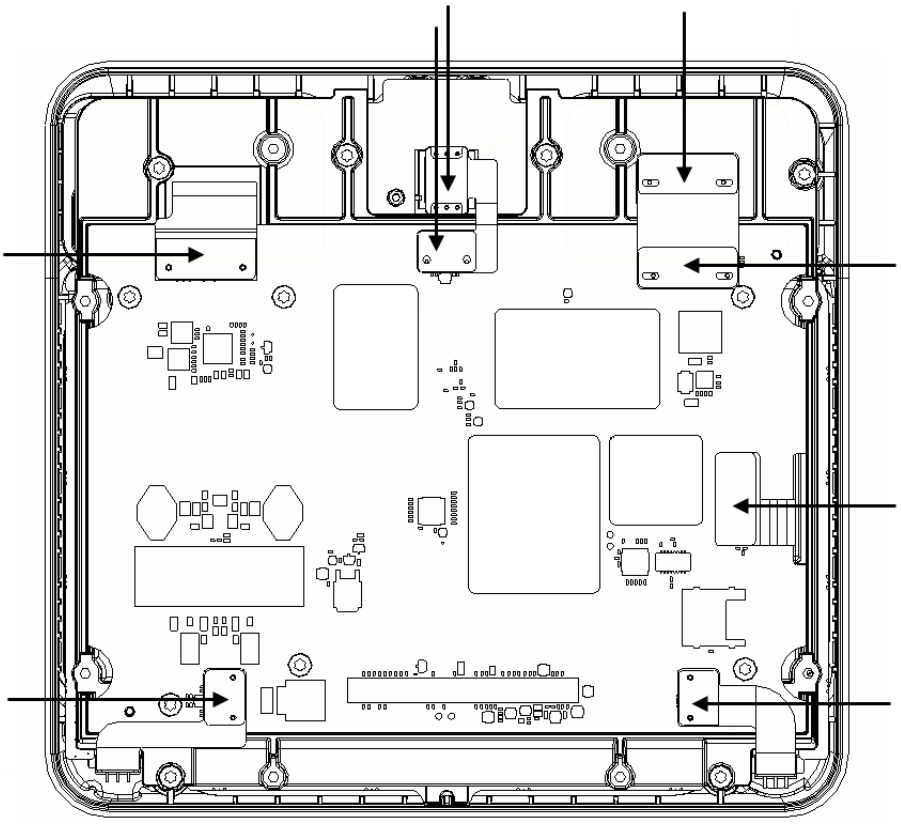
6 Carefully disconnect the main flex assembly [32] from the front housing assembly.

Figure 83: Separated Front and Back Housing Assemblies



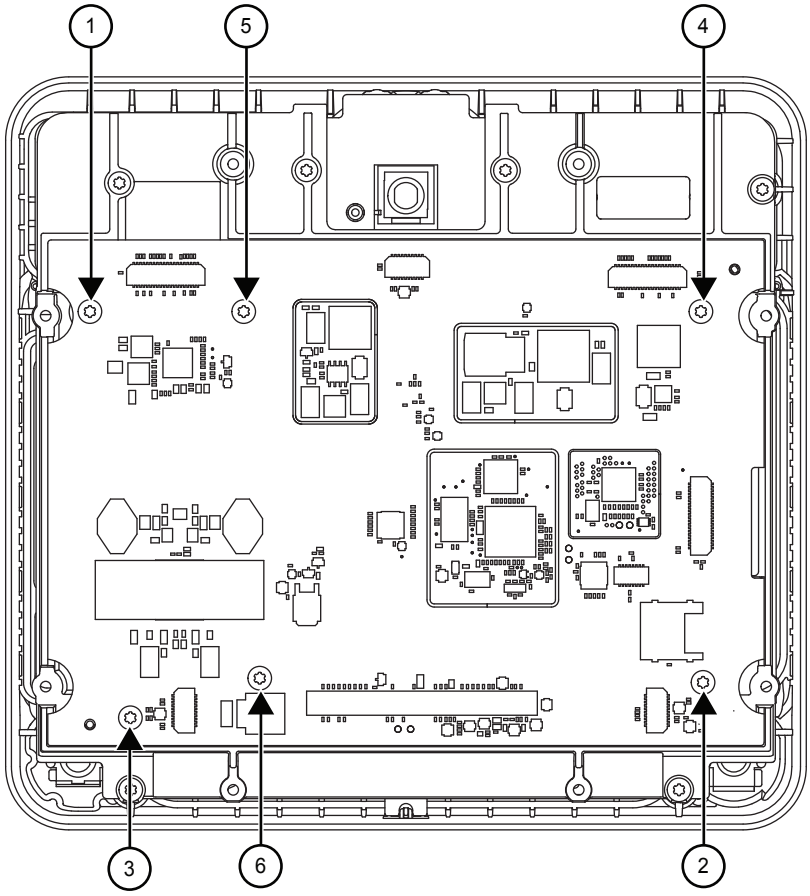
7 Carefully disconnect the remaining seven flex connectors on the front housing assembly. Remove top pursuit switch flex [12] from front housing [9].

Figure 84: Location of Flex Connectors



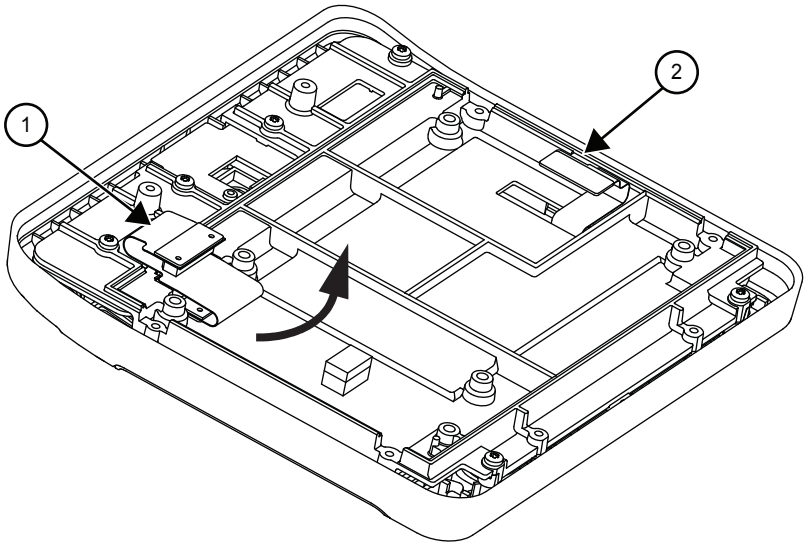
8 After all flex connectors have been disconnected, remove the six self-tapping screws [14] as shown in the following figure using a Torx T10 screwdriver, and then gently lift the main PCB [31] from the front housing assembly.

Figure 85: Self-Tapping Screws Sequence



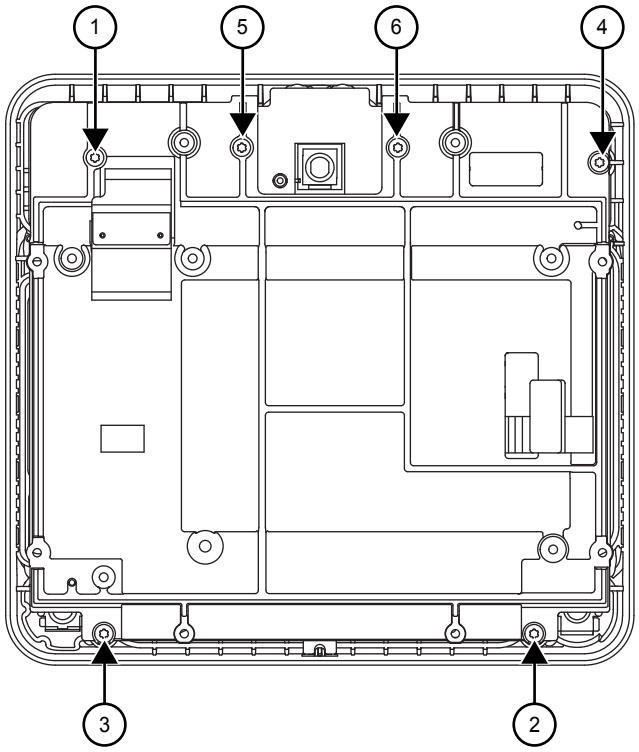
9 Carefully disconnect the front keypad flex connector [28] which connected to front keypad PCB [26] as shown in the following figure. Peel off the flex from the chassis [29] and scrap the front keypad flex [28].

Figure 86: Disconnect Frequency Flex



10 Remove the six self-tapping screws [14] as shown in Figure 78: Removing the Encoder Assembly on page 177 using a Torx T10 screwdriver.

Figure 87: Self-Tapping Screws Sequence



11 Remove the chassis [29] from the front housing assembly. Carefully ensure that the LCD flex which go through the chassis is not damaged.

12 Carefully remove top keypad PCB [27] and LCD display [15] from front housing [9]. Avoid leaving any finger marks or foreign material on the LCD display and lens on the front housing. Next, remove front keypad PCB [26].

13 Remove the pursuit light bar keypad [17] and top pursuit siren keypad [18] with the retainers [20,21]. Then, remove all the four keypads at front housing [22, 23, 24, 25] carefully to avoid tearing the web due to high engagement force of the mushroom seal.

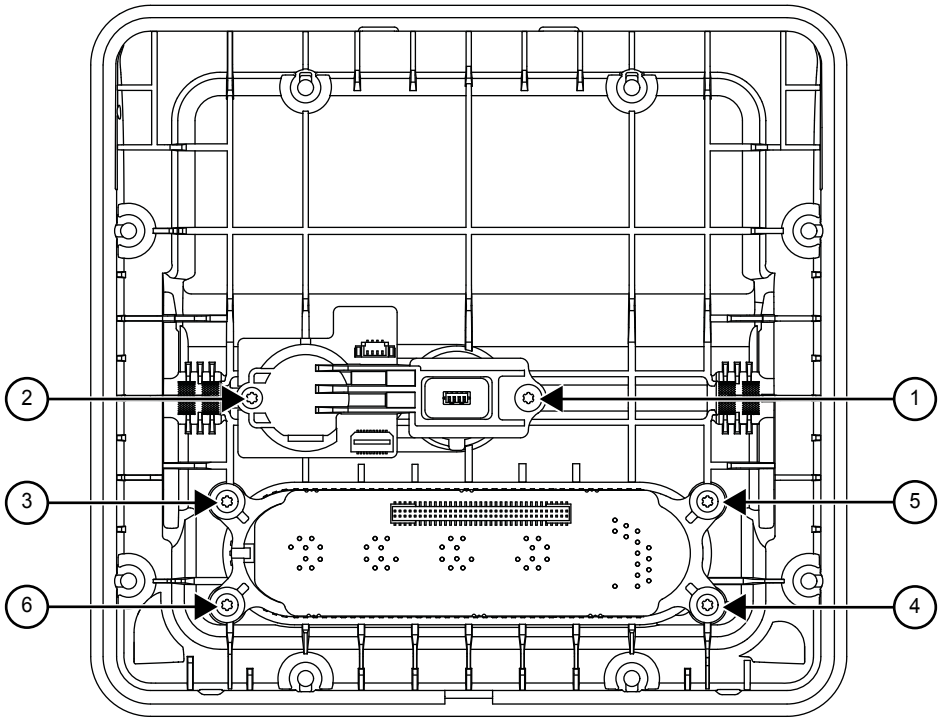
14 Place the back housing assembly on a clean, flat surface. Disassemble the main O-ring [33] around the back housing [40] from the bottom to top.

15 Carefully disconnect the main flex assembly [32] from the back housing assembly.

16 Disassemble the USB wire connector of the USB overmold [37] from the GCAI PCB [35].

17 Remove the 6 self-tapping screws [14] as shown in Figure 8-13 using a Torx T10 screwdriver, and then gently lift the CHUC PCB kit [38] from the back housing assembly. Take note that there is a CHUC seal [39] on the kit.

Figure 88: Self-Tapping Screws Sequence



18 Then, remove USB/GCAI retainer [34], follow by GCAI PCB kit [35] with GCAI seal [36] and USB overmold [37].

NOTE:
Be careful not to leave any foreign material/finger marks/others cosmetic defects on the lens and LCD module.

All flexes must be handled with care to avoid tearing/connectivity issue upon reuse (except the front keypad flex which needs to be replaced after each disassembly).

Upon removal, inspect keypad on web areas. Any keypad web torn must be scraped and replaced.

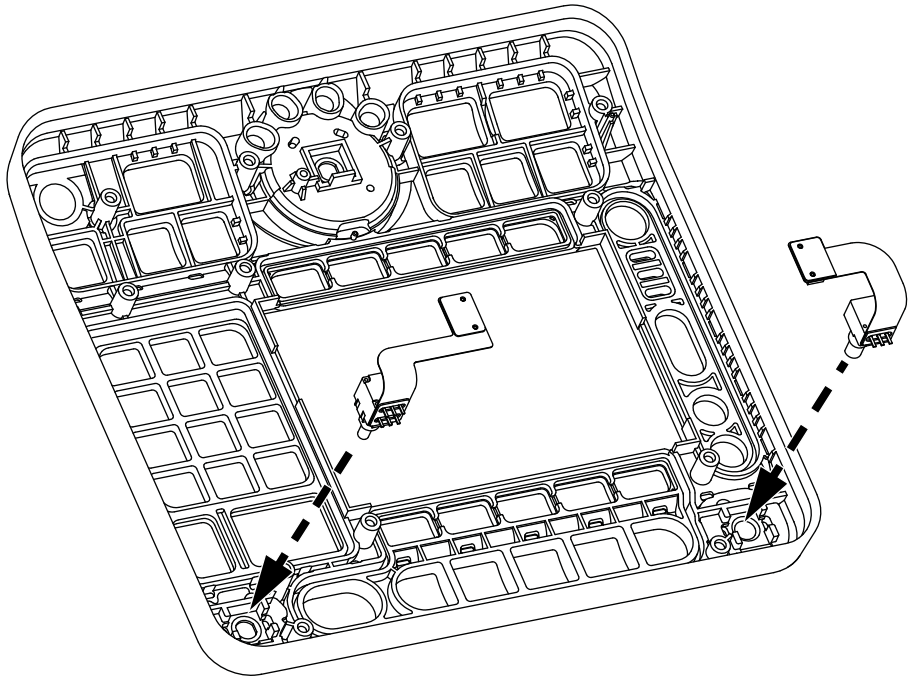
8.1.11
O9 Control Head Reassembly

NOTE: Bracketed numbers are identical to item numbers shown in Figure 323: O9 Control Head Exploded View on page 347.

Procedure:

1 To reassemble, insert the black color frequency flex indicator [10] on the left side and white color volume flex indicators on the right side [11] by pressing into the cavity on the front housing [9] as shown in the following figure.

Figure 89: Assemble Flexes Into Front Housing

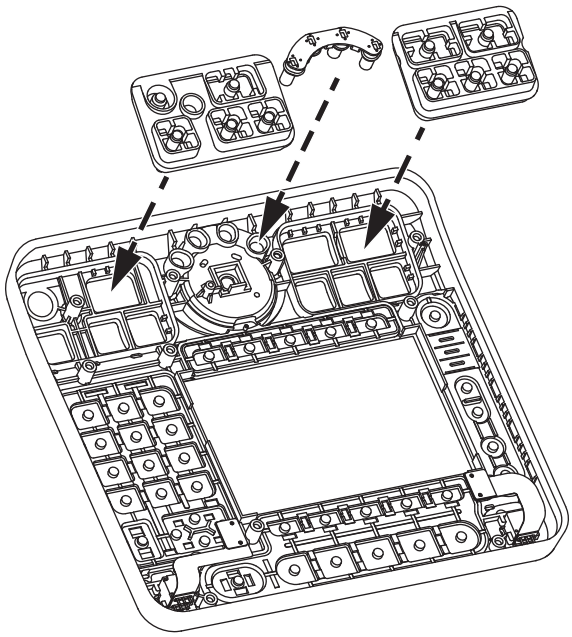


2 Flip the front housing [9] with flexes, place washers [3], and nuts [2] on the flexes indicator. Tighten the nuts with 8 mm hex nut bit at 8 in. lbs.

3 Flip back the housing and assemble all the four keypads, which included menu, brightness control keypad, DEK silicone keypad, programmable control keypad, and alpha numeric silicone keypad at front housing [22, 23, 24, 25] by pressing all the mushroom ribs until it is flush to all the guided walls as shown in Figure 81: Main PCB Retention Screw Alignment on page 179. Else, keypad sealing and tactile might be affected.

4 Pre-assemble top pursuit light bar keypad [17] and top pursuit siren keypad [18] to the retainers [20, 21]. Ensure that the keypads are properly assembled to the retainers. Next, assemble the pre-assembled keypads and retainers into the front housing by pushing the parts until the retainers flushed to the housing wall. Also, assemble the indicator light guide [19] as shown in Figure 90: Assemble Keypads and Indicator Light Guide on page 186.

Figure 90: Assemble Keypads and Indicator Light Guide



5 Place the front keypad PCB [26] by aligning to the alignment pins circled, as shown in Figure 92: Orientation Proof Features at the Housing on page 187.

6 After that, insert LCD display [15] into the rubber boot [13] and carefully place them into the lens areas as showed in Figure 91: Assemble Front Keypad PCB and LCD Display on page 186. Make sure the conductive pad [16] at the back of LCD display [15] is aligned to legends. There are orientation proof features at the housing wall for LCD display as boxed in Figure 92: Orientation Proof Features at the Housing on page 187 (Ensure no finger marks and no foreign material such as fiber on the lens and LCD display area).

Figure 91: Assemble Front Keypad PCB and LCD Display

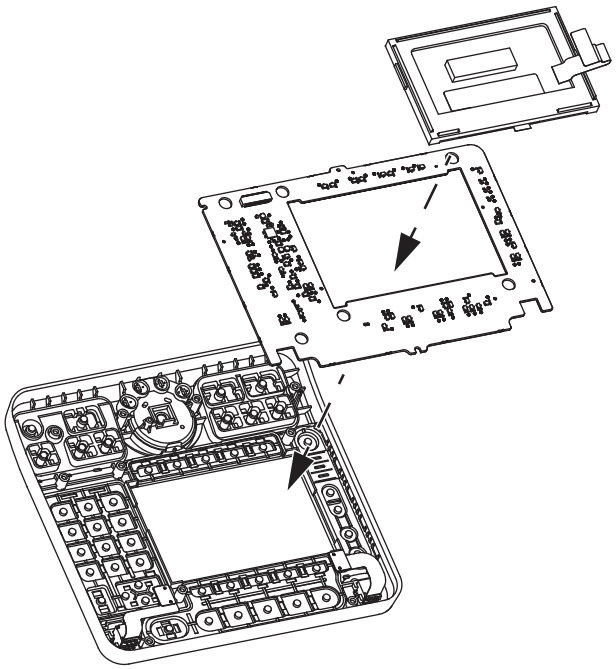
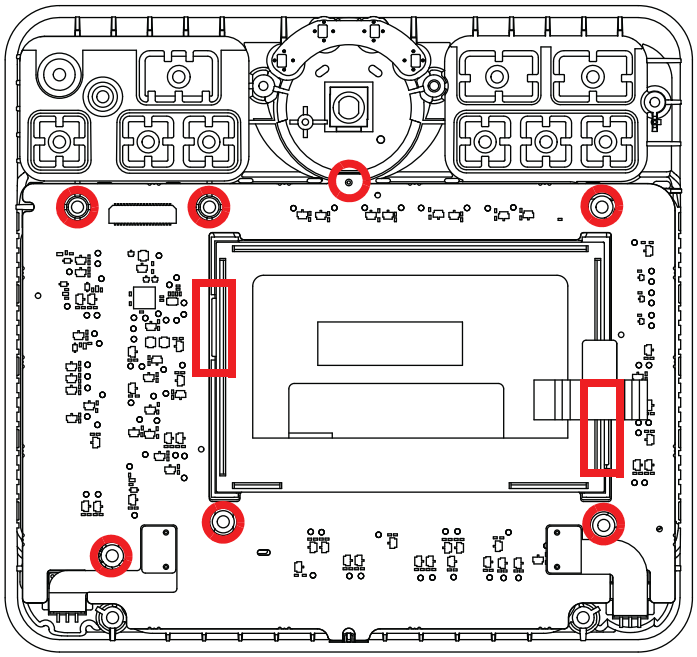
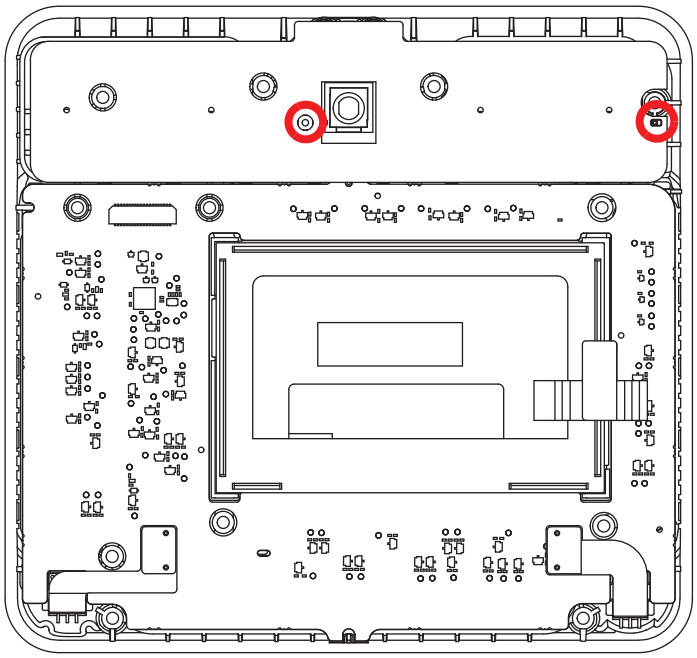


Figure 92: Orientation Proof Features at the Housing



7 Place the Top keypad PCB [27] by aligning to the alignment pins circled, as shown in the following figure.

Figure 93: Location of Alignment Pins

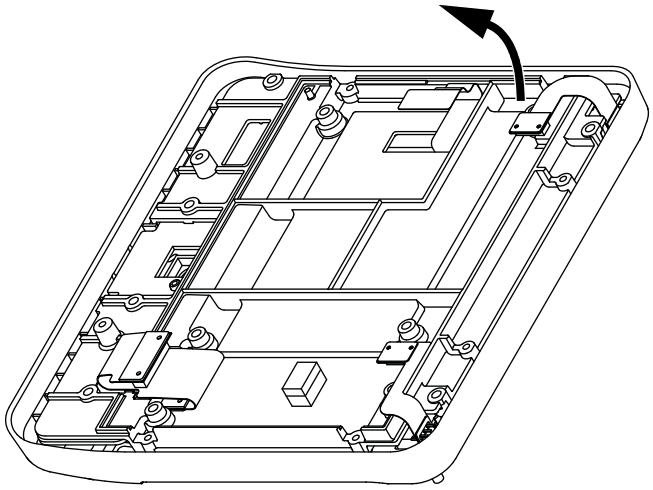


8 Place the chassis [29] on top of boards. Make sure that the frequency flex [10] and volume flex [11] are visible and not crushed by the chassis [29]. Fish through the LCD display's flex through the chassis as shown in Figure 94: Align LCD Flex and Front Keypad Flex on page

188. Assemble six T10 self-tapping screws through the screw boss and torque down 8 in. lbs by following the sequence as shown in Figure 85: Self-Tapping Screws Sequence on page 182.

CAUTION: New self-tapping screws [14] must be used. Make sure screw boss on front housing [9] and chassis [29] in good condition. Front housing [9] or chassis [29] must be replaced if it is reworked for more than ten times.

Figure 94: Align LCD Flex and Front Keypad Flex

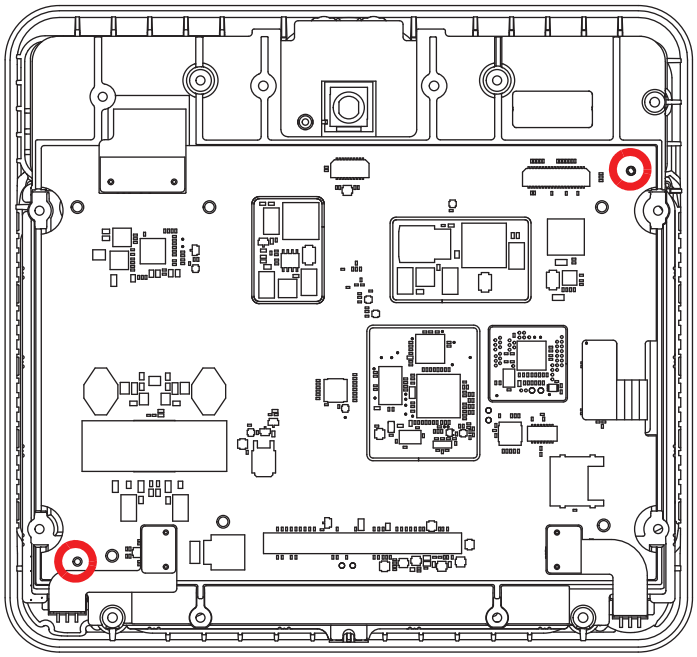


9 Connect the front keypad flex [28] to front keypad PCB [26]. Take note of the printings on the flex that indicates which end of the connector is assembled to. Remove the liner of the front keypad flex, then fold and align the flex to chassis aligning feature before pressing the flex to the chassis as shown in Figure 94: Align LCD Flex and Front Keypad Flex on page 188.

10 Assemble the main PCB [31] to the front housing assembly. Take note of the two guiding pins circled in RED as shown in Figure 95: Location of Guiding Pins on page 189. Make sure all the flexes are visible and not under the main PCB before placing the main PCB. Fasten the 6 self-tapping screws [14] as shown in Figure 85: Self-Tapping Screws Sequence on page 182 using a Torx T10 screwdriver with 8 in. lbs.

CAUTION: New self-tapping screws [14] must be used. Make sure screw boss on front housing [9] and chassis [29] in good condition. Front housing [9] or chassis [29] must be replaced if it is reworked for more than ten times.

Figure 95: Location of Guiding Pins



11 Place the top pursuit switch flex [12] into front housing [9]. After that, lay the front housing assembly faces up on a clean and flat surface. Make sure the gore port seal [5] on the front housing [9] is present. Place the pursuit spring [4], washer [3] and follow by nut. Fasten the nut with 8 mm hex nut bit at 8 in. lbs and then assemble the top pursuit knob [1].

12 Connect top keypad flex assembly [30] to top keypad PCB kit [27] and main PCB kit [31]. Take note of the printings on the flex that indicates which end of the connector is assembled to. After that, connect all the remaining flexes connector to main PCB [31] as shown in Figure 84: Location of Flex Connectors on page 181.

13 Place the back housing [40] on a clean, flat surface. Make sure the GCAI seal [36] is assembled on the GCAI PCB kit [35] and then assemble the PCB to the back housing [40] by aligning to the housing's two guiding bosses. Flip the back housing [40] and inspect for pinched GCAI seal [36].

14 Before assemble the USB overmold [37] to back housing [40], ensure the o-ring on it is present. Take note of the recess on the housing. The protrusion of the USB overmold [37] should align to the recess and pressed down. Follow by assemble USB/GCAI retainer [34] and after that assemble the USB wire connector of the USB overmold [37] to the GCAI PCB kit [35].

15 Place the CHUC seal [39] around the CHUC PCB kit [38], then assemble the PCB into back housing [40]. Fasten six self-tapping screws [14] following sequence shown in Figure 85: Self-Tapping Screws Sequence on page 182 using a Torx T10 screwdriver with 8 in. lbs.

CAUTION: New self-tapping screws [14] must be used. Make sure screw boss on back housing [40] in good condition. Back housing [40] must be replaced if it is reworked for more than 10 times.

16 Assemble the main O-ring [33] around the back housing [40] from the bottom to top. Ensure that the main O-ring is seated in the housing groove.

17 Carefully connect the main flex assembly [32] to the GCAI PCB kit [35] and CHUC PCB kit [38]. To avoid damaging the connectors, take out the back housing [40] and hold vertically to align the main flex connector to the CHUC Connector.

18 After that, carefully assemble the other end of the main flex connector to the main PCB [31]. Bend the main flex assembly [32] and close the back housing assembly and front housing assembly together.

19 Prepare 8 new screw assemblies [44] and ensure that the washer and green o-ring is in place. Using a Torx T10 screwdriver, fasten the 8 screws [44] with 10 in. lbs as shown in Figure 82: Control Head Screw Sequence on page 180.

20 Assemble the torque enhancer [7] for the volume knob [6] and frequency knob [8]. Then, ensure all the knobs are with D-clips inserts. Finally, assemble all the knobs to the front housing.

CAUTION: New screw assemblies [44] must be used. Make sure screw boss on back housing [40] in good condition. Back housing [40] must be replaced if it is reworked for more than ten times. Wrong assembly could damage water sealing.

NOTE:
Be careful not to leave any foreign material/finger marks/others cosmetic defects on the lens and LCD module.

All flexes must be handled with care to avoid tearing/connectivity issue upon reuse (except the front keypad flex which to be replaced after each disassembly).

Any keypad web torn must be scraped and replaced.

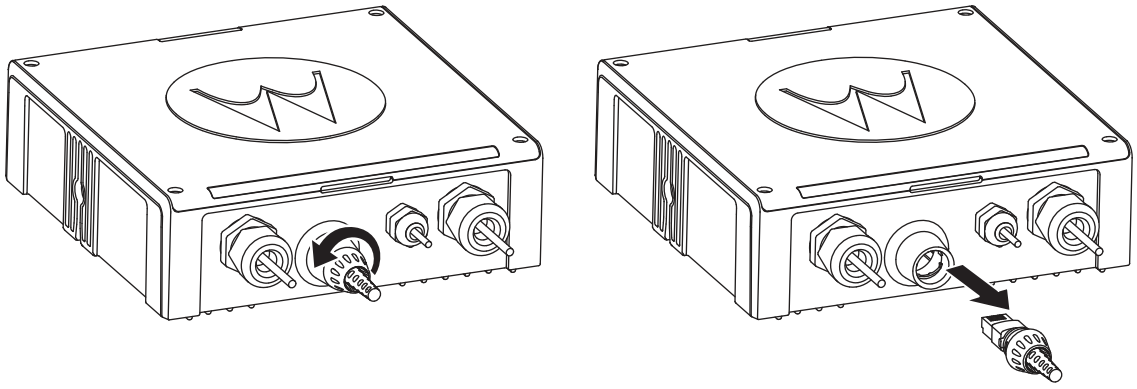
8.1.12
O9 Universal Relay Controller Disassembly

NOTE: The Universal Relay Controller (URC) is an accessory that can be ordered for O9 Control Head. Bracketed numbers are identical to item numbers shown in Figure 341: Universal Relay Controller Exploded View on page 380.

Procedure:

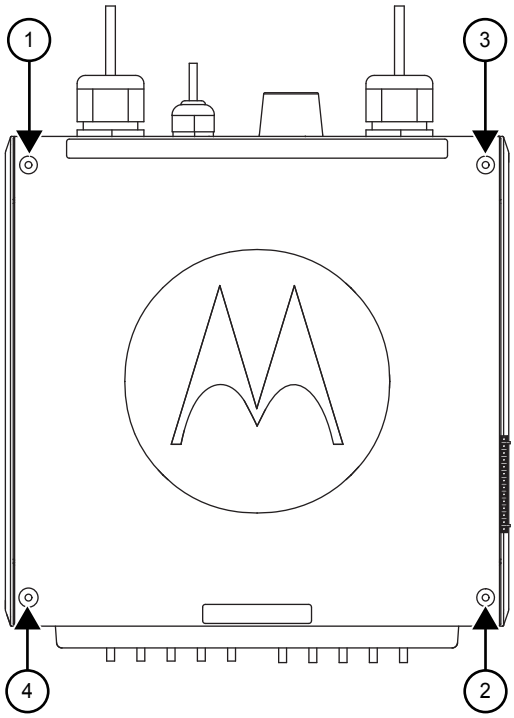
1 Remove O9 to URC cable (3064153H02) by twisting the cable lock counter-clockwise (quarter turn) as shown in the following figure.

Figure 96: Cable Lock Detachment



2 Using a Philip screw bit size PH2 screwdriver, remove the four Universal Relay Controller screws [1] as shown in the following figure.

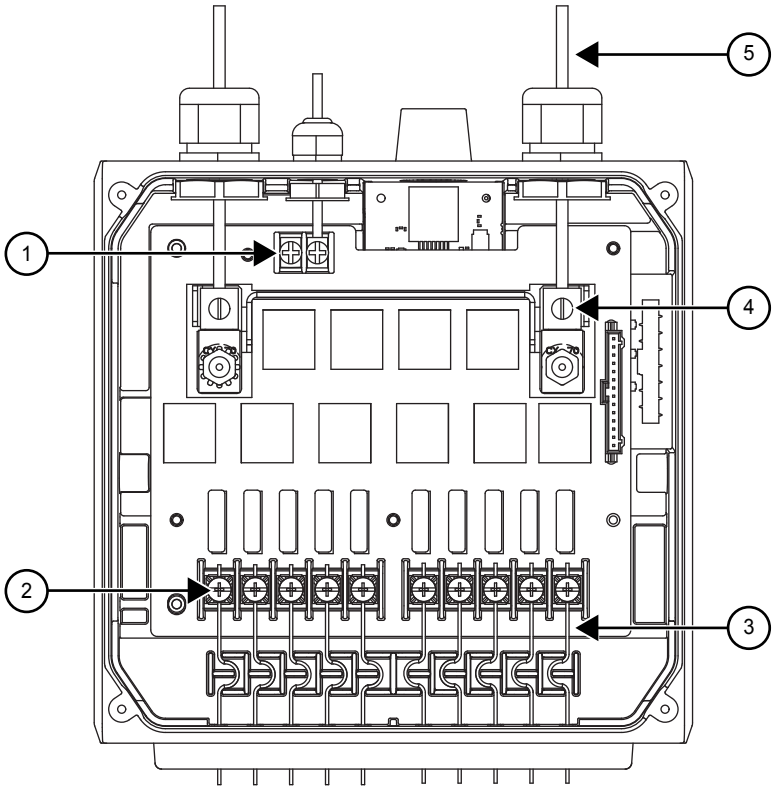
Figure 97: Universal Relay Controller Screw Sequence



3 Carefully separate the top housing [2] from the chassis [20].

4 Unscrew all the light bar terminal block screws, ground terminal block screws, and power lugs screws to remove the wires.

Figure 98: Universal Relay Controller Wire Connections



1	Ground Terminal Block Screws
2	Light Bar Terminal Block Screws
3	Wires
4	Power Lugs Screws
5	Wire

5 Remove the wires which are attached to the light bar terminal block.

6 Remove the two screws on the retainer to remove the light bar gasket retainer [22] and light bar gasket [21] with a screwdriver with Philips PH2 screw bit.

7 Open the cap nut of the power and ground cable glands [12, 16] to remove the wires.

8 Carefully disconnect the wire harness from the controller board with the other end of the wire harness still connected to the relay board. Remove all the five machined torx screws [4] on the relay board and gently lift the relay board from the Universal Relay Controller chassis [20].

9 Lay the relay board [9] on a clean and flat surface and disconnect the wire harness.

10 Using a Torx T10 screw driver, remove the two machined Torx screws [4] on the controller board and gently lift up the controller board from the chassis [20].

11 Use a 25 mm and 15 mm hex nut bits to disassemble the power and ground cable glands [12, 16].

12 Remove the port seal [19] at the chassis [20] with a tweezers.

8.1.13
O9 Universal Relay Controller Reassembly

Procedure:

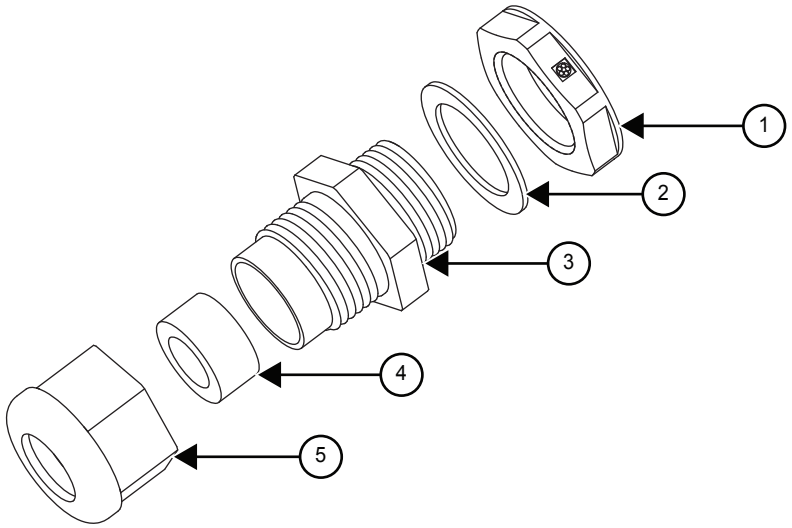
1 Place the two light bar gasket into the chassis [20] recess and then place the light bar gasket retainer [22] onto the chassis [20] on top of the two light bar gaskets [21].

2 Using a Philips PH2 screwdriver, fasten the 2 philips screws [1] through screw boss on gasket retainer [22] (torqued to 5 in. lbs).

3 Assemble the port seal [19] to the chassis [20] recess using a plastic tweezer. Press it to ensure the port seal is sealed properly on the housing.

4 Insert gasket into cable gland body. Pre-tighten the cable gland counter nut and cable gland body on the chassis [20]. Repeat this action for both the power and ground cable glands [12, 16]. Fasten the power cable gland to 38 in. lbs with a 25mm hex nut bit. Meanwhile, torque the ground cable gland at 13 in. lbs with a 15mm hex nut bit. Place the cap nuts and turn a few turns. Make sure the neoprene seal in cable gland is present. Refer to the following figure for cable gland assembly with gasket.

Figure 99: Cable Gland Assembly with Gasket



1	Counter Nut
2	Gasket, Cable Gland
3	Cable Gland Body
4	Neoprene Seal
5	Cap Nut

5 Place the controller board [10] into the chassis [20] by following the recess. Ensure the board is aligned to the two guiding pins. Fasten the screws [4] to 8 in. lbs with a T10 screw bit. Replace the 2 thermal pads [18] to the main chassis. **Do not** reuse the old part.

6 Assemble the wire harness [6] to the controller board [10]. Ensure that the protrusions of the wire harness are aligned correspondingly to the connector's recess.

7 Place the relay board [9] into the chassis [20]. Ensure the board is aligned to the two guiding pins. Fasten the screws [4] to 8 in. lbs with a T10 screw bit. After that, assemble the other end of the wire harness to the relay board. Ensure that the protrusions of the wire harness are aligned correspondingly to the connector's recess.

8 Assemble the O-ring [3] to the top housing [2]. Place the top housing on top of the chassis [20] and press the top housing down. Ensure the O-ring is not pinched.

9 Fasten the screws [1] to 5 in. lbs by using a Philip screw bit size PH2. Follow the screw sequence in Figure 97: Universal Relay Controller Screw Sequence on page 191.

8.1.13.1

Chassis Thermal Pad Replacement

Use the following procedures for replacing the chassis thermal pads. To replace the thermal pads:

Procedure:

1 Use a plastic flat-edge tool (like a black-stick solder aid) to lift the pad from the chassis surface.

2 Discard the old pad. Use a soft cloth to remove any remaining residue. Alcohol can also be used, if necessary. Care should be taken to minimize any cleaning-agent contact with the surrounding shield gasket.

3 Once the surface is clean and dry, use tweezers to remove a new pad from the shipping liner, and place it down on the chassis.

4 Apply pressure to the pad to activate the pressure-sensitive adhesive.

CAUTION: Use of a metal tool will scratch the heat sink surface and reduce the thermal effectiveness of the thermal pad which is used to heat sink heat-sensitive components. Loss of thermal effectiveness of the thermal pads could result in the overheating of heat-sensitive radio components and result in their damage.

8.1.14
O9 Universal Relay Controller Cable Assembly

8.1.14.1
Power Cable

Procedure:

1 Remove the cap nut of power cable gland assembly [12], insert the power cable through the cap nut and then the neoprene seal in cable gland body. Use only power cable with either AWG 6 or AWG 8 (recommended OD range of cable is 5.5 mm to 9 mm) that are able to withstand 80 A and 50 A respectively to ensure water sealing of the control box. User can decide to install one or two power cables based on the requirements. The power cables (A+) will not be supplied.

2 The loose end of the power cable with cable strip length 7.94 mm (5/16”) is then placed on the power lug and secured down by a set screw. The cap nut is then assembled back with tightening torque 18 in. lbs.

3 The other end of the power cable should be connected to one end of the circuit breaker (40012006001) labeled **AUX**. Then, connect the power supply to the other end of the circuit breaker labeled **BAT**. Do not connect the power cable directly to the power supply.

4 Repeat step 1 to step 3 to install the second power cable if it is required.

5 If only install one power cable, the other side of power cable gland is recommended to cover with power cable gland seal [11] with tightening torque 18 in. lbs.

8.1.14.2
Ground Cable

Procedure:

1 Remove the cap nut of ground cable gland assembly [16], insert the ground cable through the cap nut and then assemble back the cap nut. Use only ground cable with AWG 14 (recommended OD range of cable is 2 mm to 4 mm) that are able to withstand 5A. The ground cables (A+) will not be supplied.

NOTE: The ground is used to simply switch the relays and not act as a ground to the actual device being controlled.

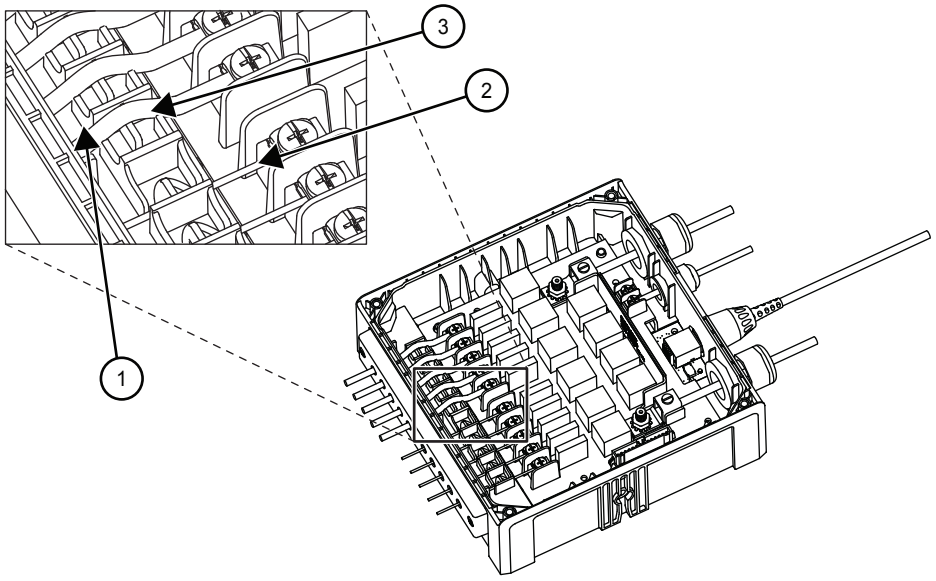
2 The loose end of the ground cable with cable strip length 7.94 mm (5/16”) is then connected to a two-pin terminal block, both pins on the terminal block are inter-connected and either pin can be used. The cap nut is then assembled back with tightening torque 7lb-in.

8.1.14.3
Wires

Procedure:

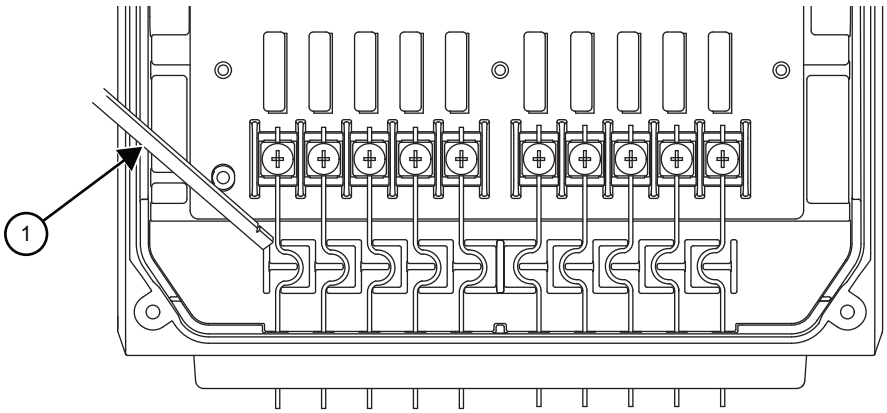
1. Assemble the wires into the light bar gasket retainer [22] and light bar gasket [21]. The Universal Relay Controller can support light bars through control wires with outer diameter ranging from 1.52 mm to 3.77 mm (0.06” to 0.148”) which wire gages ranging from AWG12-20.
2. Each individual loose wire (before stripping off the wire jacket) needs to be inserted one at a time through the chassis [20]. Ensure that the lightbar wire is straight prior inserted the wire into the chassis [20]. Each wire is sealed individually by the radial gasket seal. When thick wire (for example, AWG 14 wire or wire OD >2.90 mm) is inserted through the chassis, there is potentially rubber gasket torn. Remove the rubber gasket residual and continue to the next step.
3. Thin wires 2.5 mm and below should be dressed into the retention feature using a black stick (see Figure 101: Wire Installation with Black Stick on page 196); thick wires above 2.5 mm should be routed above the retention feature. Strip off the wire until 7.94 mm (5/16”) after the wire is inserted into Universal Relay Controller and installs the wire into respective light bar terminal block.

Figure 100: Wires Installation



1	Wires with diameter above 2.5 mm
2	Wires with diameter 2.5 mm and below
3	Wire retention feature

Figure 101: Wire Installation with Black Stick



1	Black Stick

4 The light bar gasket [21] should be replaced at each reassembly of the lightbar control wire.

5 Cover the light bar gasket retainer hole [22] with seal, gasket, and ground cable gland [14] if no wire is inserted.

NOTE: Use of other cable gages except as recommended in this manual may result in water intrusion. Any reassembly of wire needs a new lightbar gasket replaced. If the current loading for one wire is higher than 12 A, the wires should be split before being assembled to the Universal Relay Controller system. Wires Kit (PMKN4109A) is provided to ease installation of the URC. Incorrect use of this wires kit like improper connection at external loose end wires may impact the robustness of the URC.

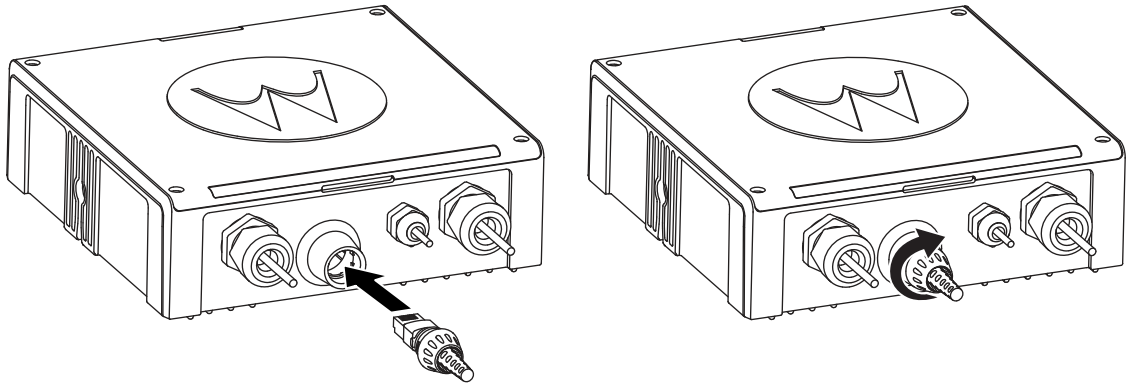
6 Remove the wires and gasket residual inside the URC after the wire installation, before closing the top housing of the URC.

8.1.14.4
O9 to URC Cable

Procedure:

1 The O9 to URC cable (P/N: 3064153H02) can be assembled either before or after assemble back the top housing. Assemble the RJ45 port of the cable into the RJ45 connector on the Universal Relay Controller and turn the locking collar instead of cable 90 degree to the right to make sure it is lock properly. After this, test whether the cable is lock properly or not by trying to pull out the cable.

Figure 102: O9 to URC Cable Installation



CAUTION: Make sure cables and wires are assembled correctly. Wrong assembly could damage water sealing.

8.1.15

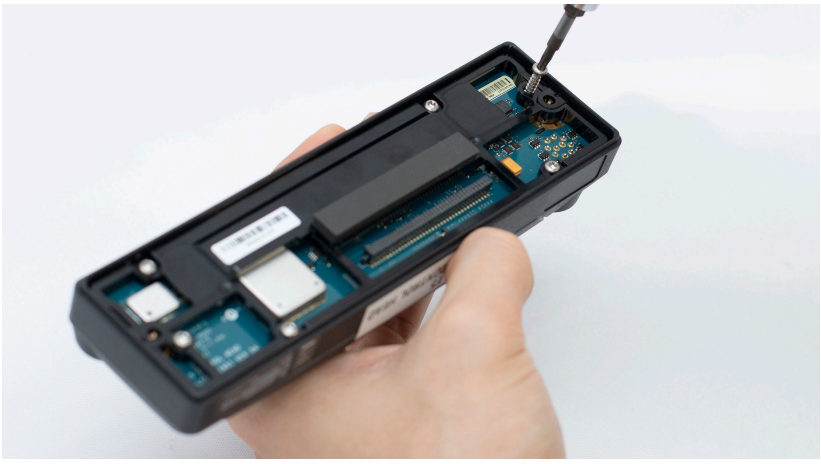
Disassembling the E5 Control Head

NOTE: Bracketed numbers are identical to item numbers shown in E5 Control Head Exploded View and Parts List on page 349.

Procedure:

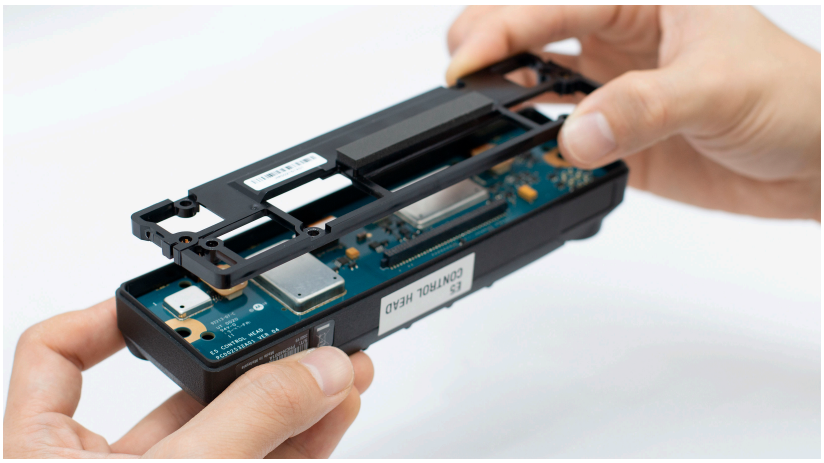
1. Lay the control head face down on a clean, flat surface being careful not to scratch or mar the display.
2. Using a Torx T10 screwdriver, remove the six main PCB retention screws [27] as shown in the following figure.

   Figure 103: Main PCB Retainer Screws



3. Carefully separate the main PCB retainer [26] from the front housing assembly.

Figure 104: Main PCB Retainer

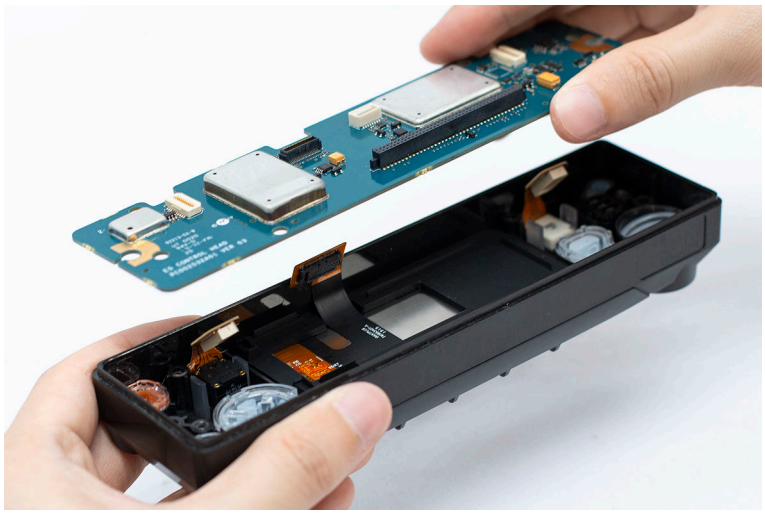


4 Carefully disconnect the frequency assembly, color display module encoder and the volume assembly flex assemblies.

5 After all the connectors have been unplugged, gently lift the main PCB up from the front housing assembly.

NOTE: Be careful not to damage the flex connectors when lifting up the main PCB.

Figure 105: Main PCB



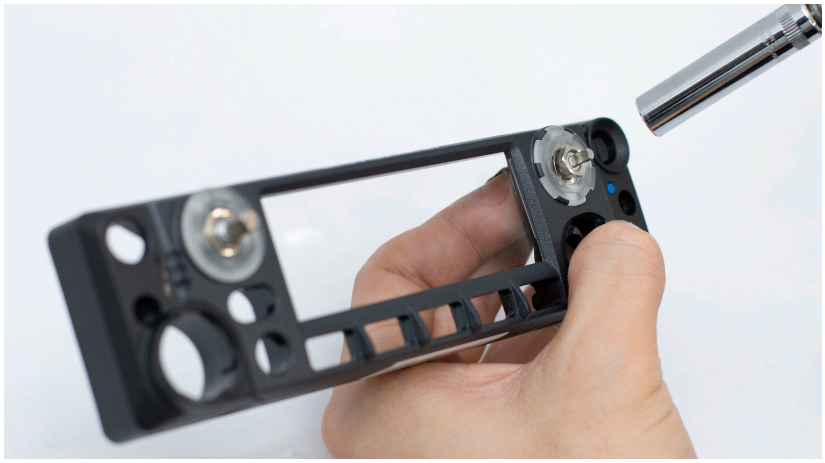
6 Remove the color display module from the front housing assembly.

Figure 106: Color Display Module

7 Using the knob removal tool, remove the encoder knob [1] from the front housing assembly.

8 Remove the torque washers and by using a hex nut driver, remove the encoder hex nut [4], followed by the 3 wave washers. Do not reuse the encoder hex nut.

Figure 107: Removing Hex Nut



9 Carefully remove the following parts from the front housing:

Figure 108: Emergency Button [20] and Emergency Button Retainer [21]

Figure 109: Home Button [14] and Home Button Retainer [15]

Figure 110: Navigation Button [16] and Navigation Button Retainer [17]

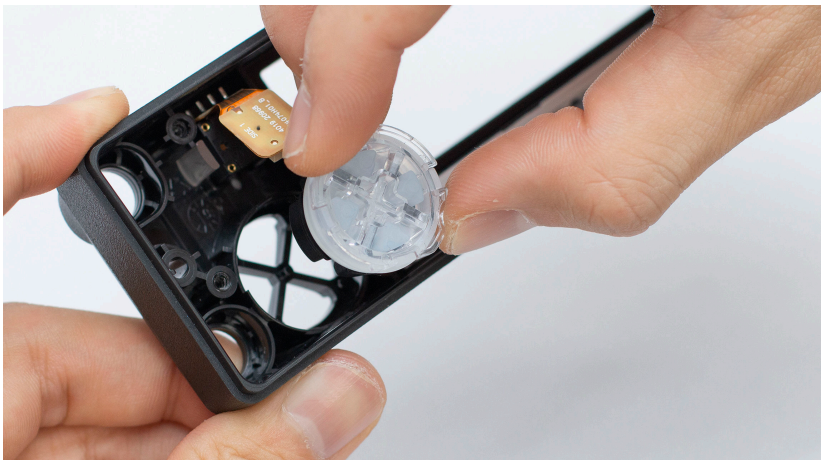


Figure 111: Menu Button [18] and Menu Button Retainer [19]

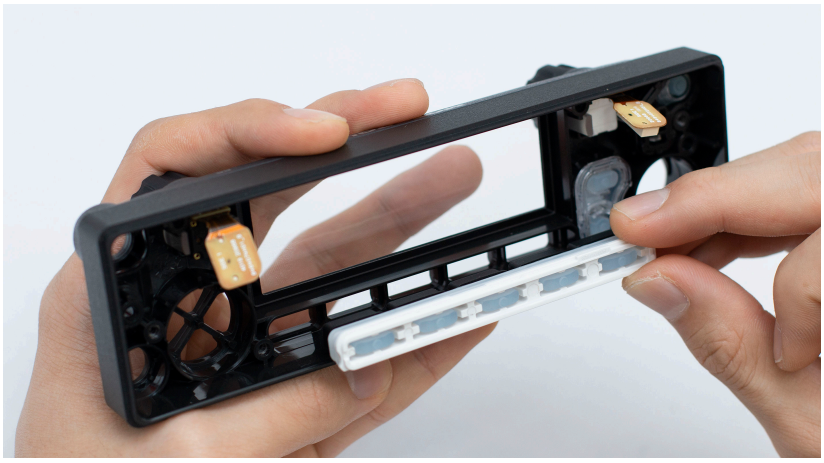
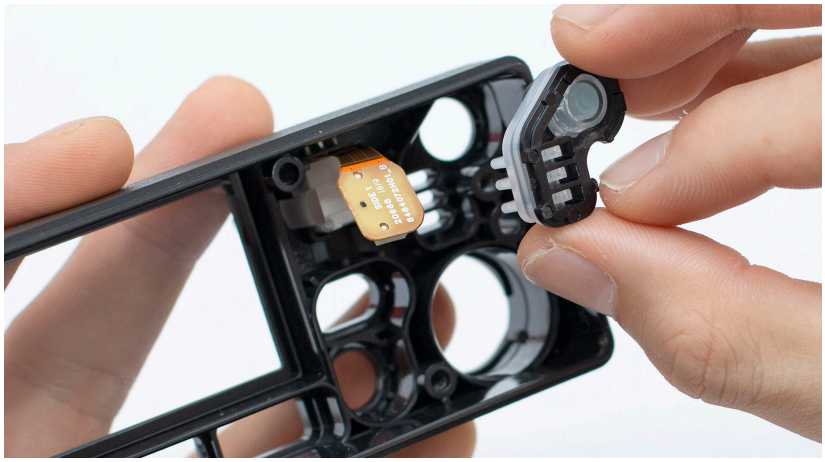


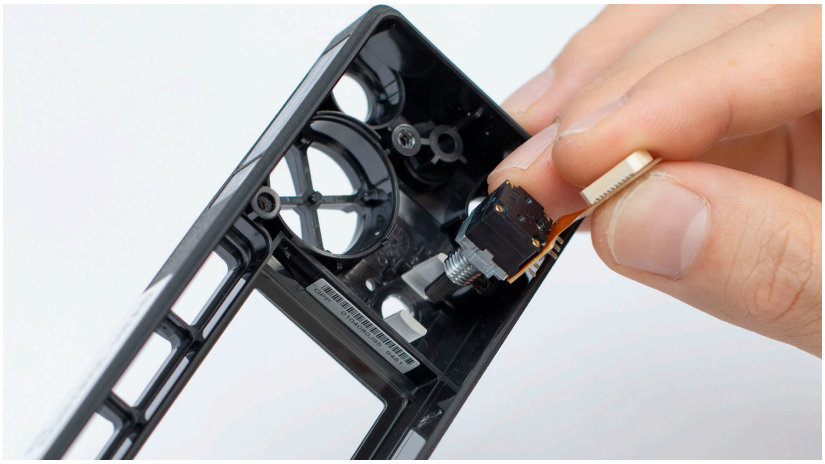
Figure 112: Programmable Button [12] and Programmable Button Retainer [13]

Figure 113: Power Button and Indicator Lights assembly [9][10][11]



10 Remove the volume assembly potentiometer and the frequency assembly switch from the front housing.

Figure 114: Volume Assembly Potentiometer



8.1.16

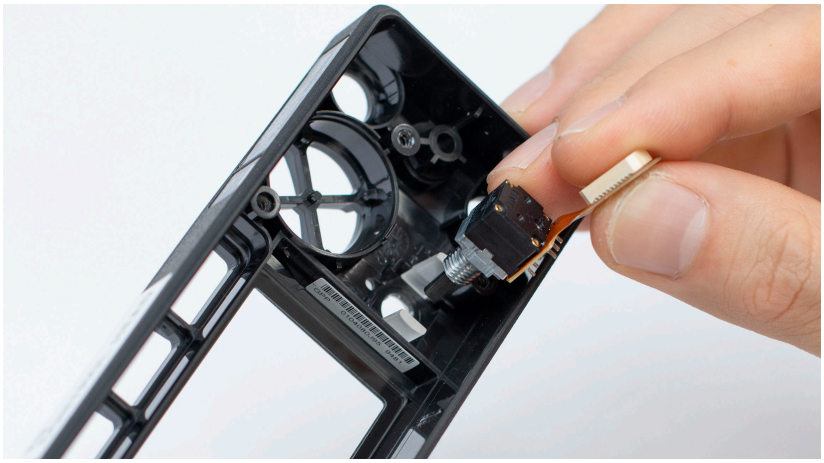
Reassembling the E5 Control Head

NOTE: Bracketed numbers are identical to item numbers shown in E5 Control Head Exploded View and Parts List on page 349.

Procedure:

1. To reassemble, ensure that the front housing is clean from any dust or debri.
2. Insert the volume assembly potentiometer and the frequency assembly switch on the front housing.

   Figure 115: Volume Assembly Potentiometer

3. Place the 3 Wave washers and using a hex nut driver, fasten the new encoder hex nut [torque to 4.5 in. lbs.].

   Figure 116: Installing 3 Wave Washers

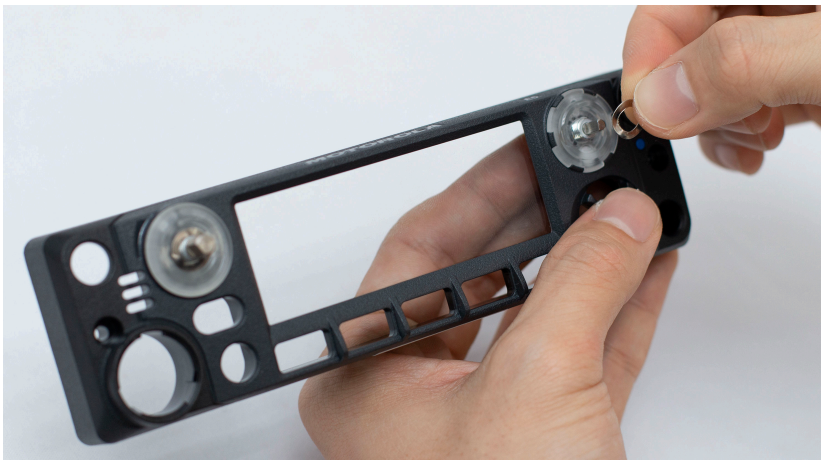
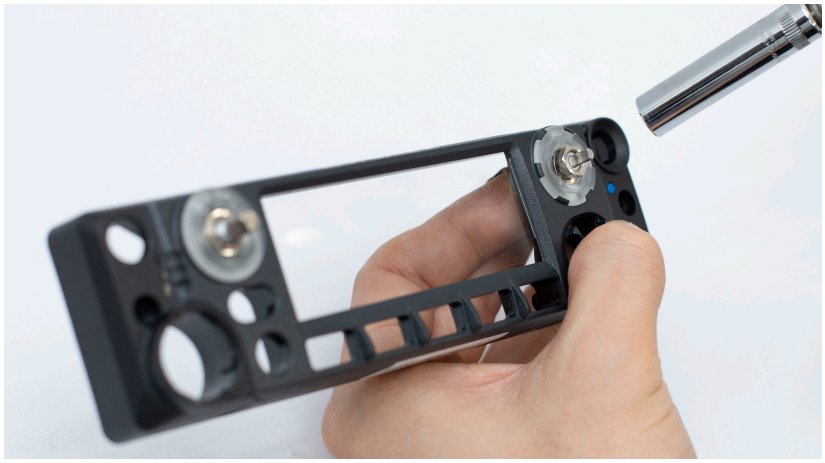
   

Figure 117: Fastening Hex Nut



4 Slot in the torque washers and install both the volume and frequency knobs.

Figure 118: Torque Washer

Figure 119: Installing Volume and Frequency Knobs

5 Slot in the following parts and ensure that they are fully seated into the front housing:

Figure 120: Power Button and Indicator Lights assembly [9][10][11]

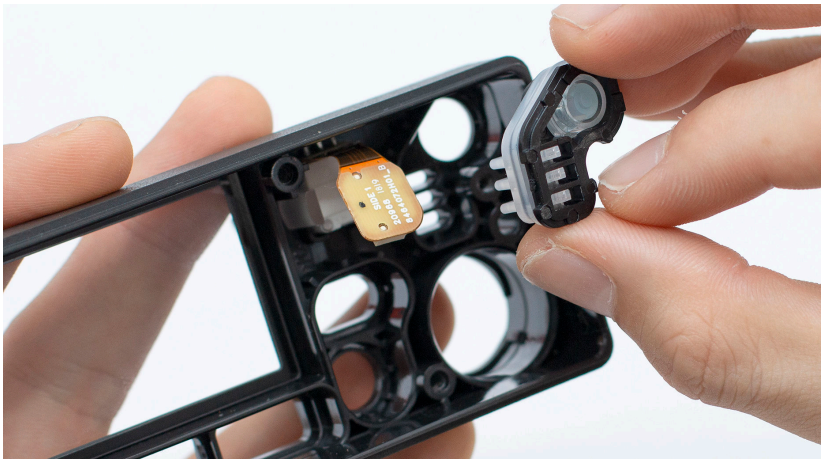


Figure 121: Programmable Button [12] and Programmable Button Retainer [13]

Figure 122: Menu Button [18] and Menu Button Retainer [19]

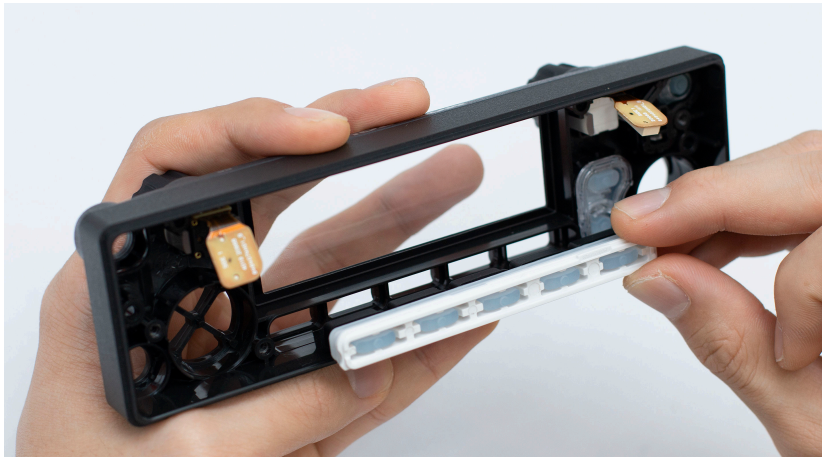


Figure 123: Navigation Button [16] and Navigation Button Retainer [17]

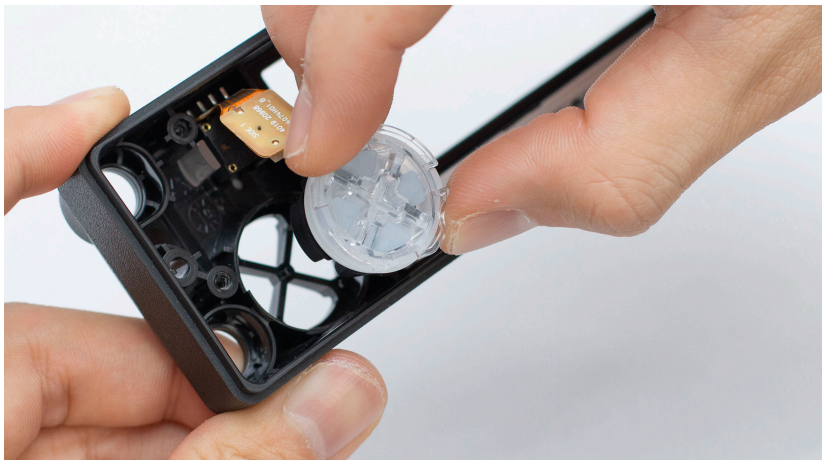


Figure 124: Home Button [14] and Home Button Retainer [15]

Figure 125: Emergency Button [20] and Emergency Button Retainer [21]

6 Install the color display module in the front housing.

Figure 126: Color Display Module

7 Place the Main Board PCB and Main Board retainer in the front housing and ensure that the flex assemblies are not covered.

Figure 127: Main Board PCB

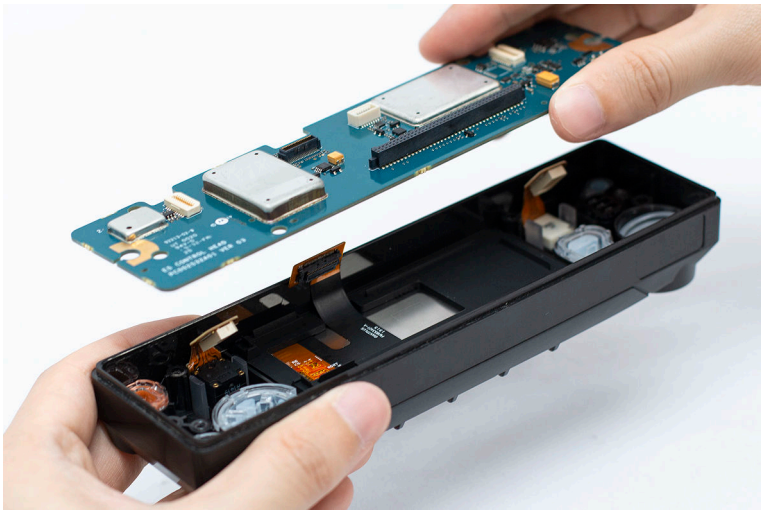
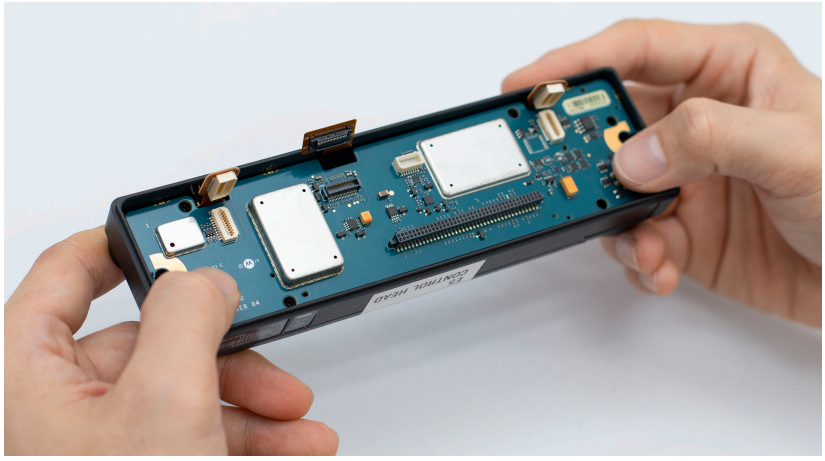


Figure 128: Volume, Frequency and Color Display Module Flex Assemblies



8 Plug in the frequency assembly flex, color display module encoder flex, and the volume assembly flex onto the Main Board PCB.

Figure 129: Frequency Assembly Flex

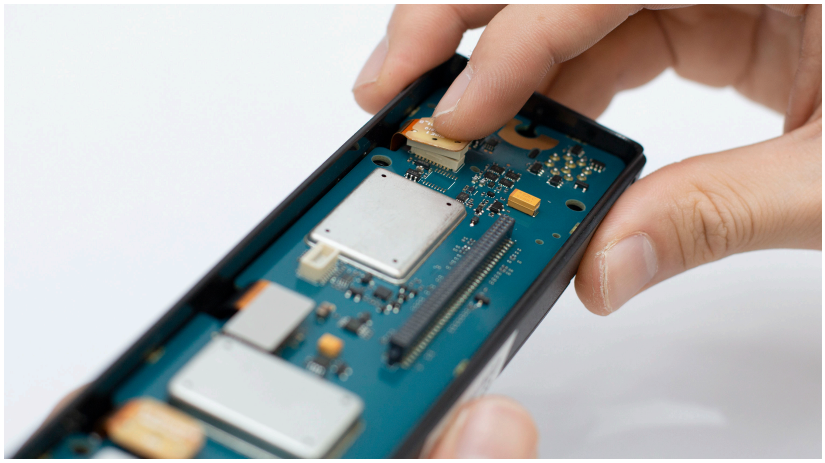


Figure 130: Color Display Module Flex

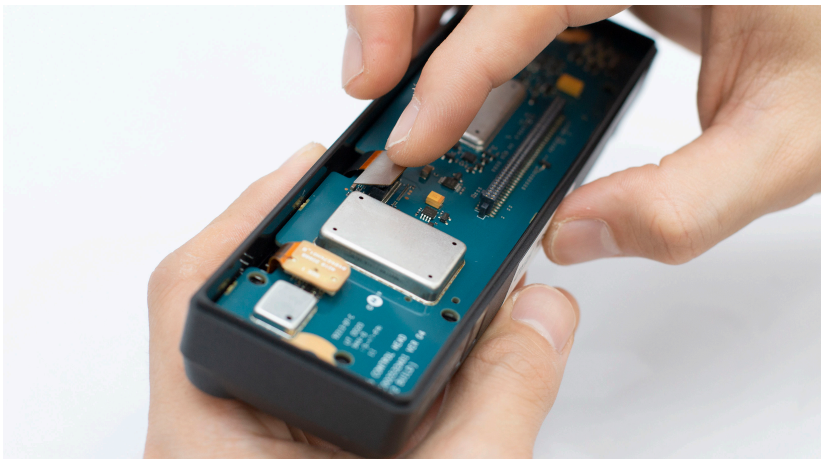
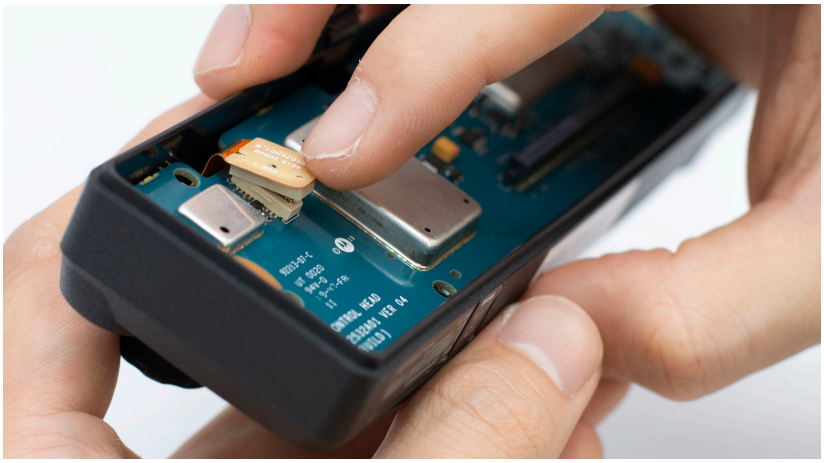
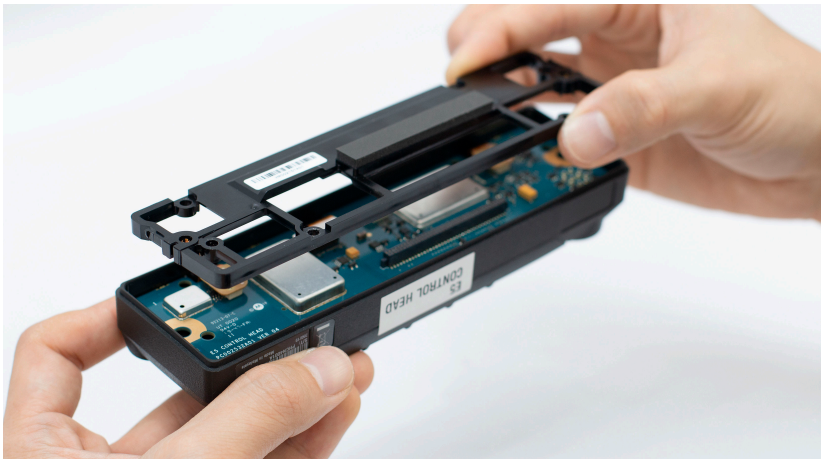


Figure 131: Volume Assembly Flex



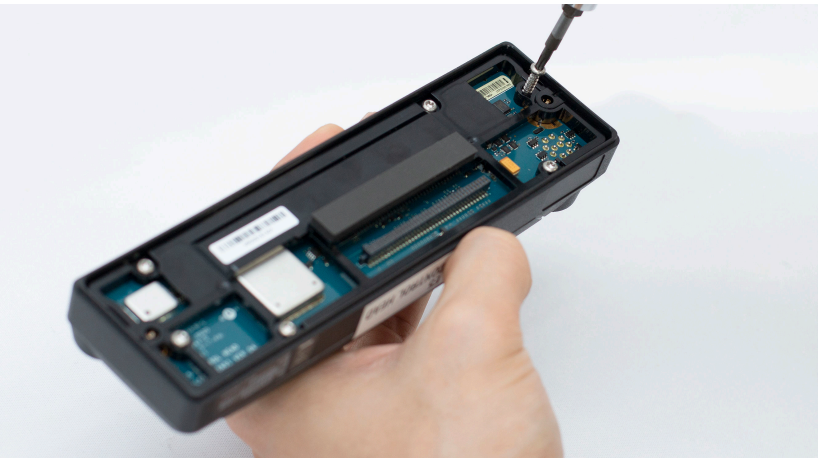
9 Place the main PCB retainer in the front housing, and it all the way to the left to ensure the screw bosses align with the corresponding holes in PCB and retainer.

Figure 132: Main PCB Retainer



10 Using a Torx T10 screwdriver, fasten the six PCB screws (torque to 6 in. lbs.).

Figure 133: Main PCB Retainer Screws



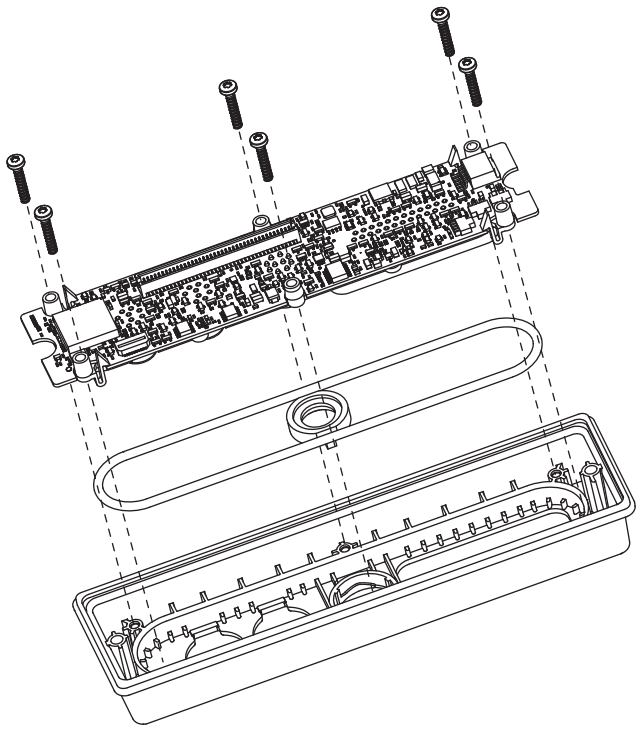
8.1.17
Transceiver Interface Board Disassembly/Reassembly

8.1.17.1
Mid Power Model Disassembly

Procedure:

1. To remove the front panel from the front of the radio, follow the disassembly procedure outlined in APX 5500/APX 6500/APX 7500/APX 6500Li Mid Power Models on page 213, steps 1 to 5.
2. Place the front panel face down on a flat surface and remove the six interconnect board retaining screws with a T10 Torx driver.
3. Remove the TUC seal from the connector on the front side of the board.

Figure 134: Front Panel Disassembly for Mid Power Model



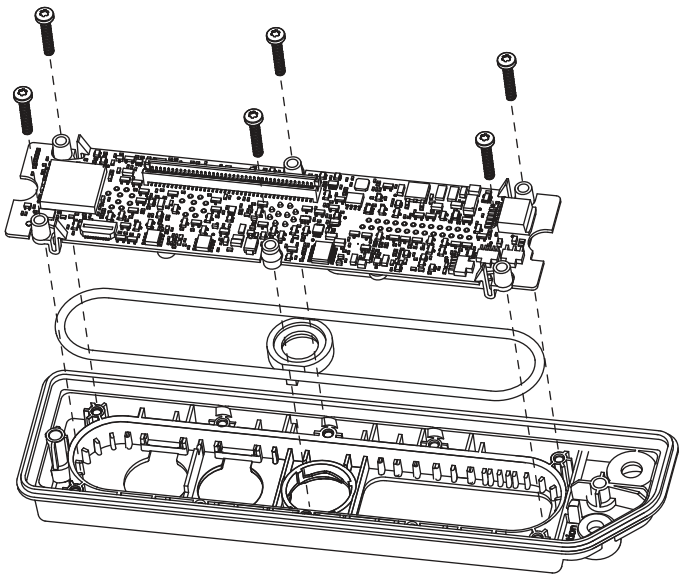
8.1.17.2

High-Power Model Disassembly

Procedure:

1. To remove the front panel from the front of the radio, follow the disassembly procedure outlined in Disassembling the Radio on page 224, steps 1 to 3.
2. Place the front panel face down on a flat surface and remove the six interconnect board retaining screws with a T10 Torx driver.
3. Remove the TUC seal from the connector on the front side of the board.

Figure 135: Front Panel Disassembly for High-Power Model



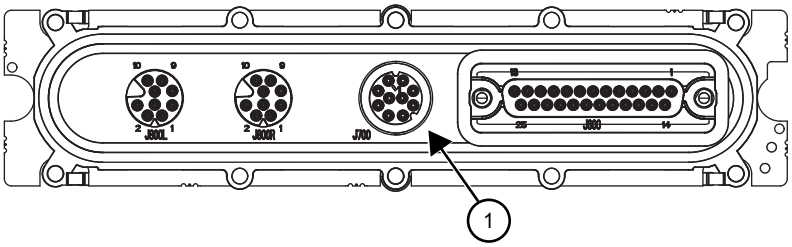
8.1.17.3

TIB Model Reassembly

Procedure:

1. Install the TUC seal ensuring it is seated properly to the TUC connector, then install the remote interconnect board onto the front panel, and replace the screws. Torque the screws to (6-8 in.-lbs).
2. Ensure that the front seal is properly seated to the radio.

   Figure 136: TUC Seal Placement



1	Front Panel Seal

CAUTION: Never attach or remove a flex with power supplied to the radio. Also, take care to avoid misalignment of Flex connector pins upon re-attachment. Failure to remove power or align properly can result in electrical shorting of the circuit board and possible component damage.

3. Reconnect the interconnect flex to the TUC PCB then connect the flex to the radio, noting proper alignment of the mating connections.
4. Place the Frame Seal (MP part number: 3264059H03; HP part number: 3271902H01) onto the TIB housing.
5. Reassemble the front panel TIB assembly into the radio, with Frame Seal attached and replace the screws.

6 Torque the screws to (6-8 inch-lbs). Over-torque of the screws can result in warping of the circuit board and possible board damage.

Figure 137: Front Panel Reassembly for Mid Power Model

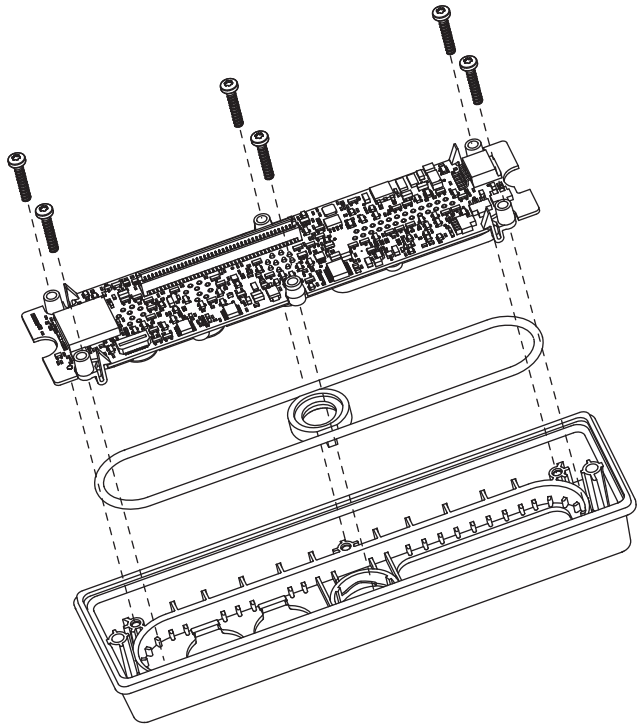
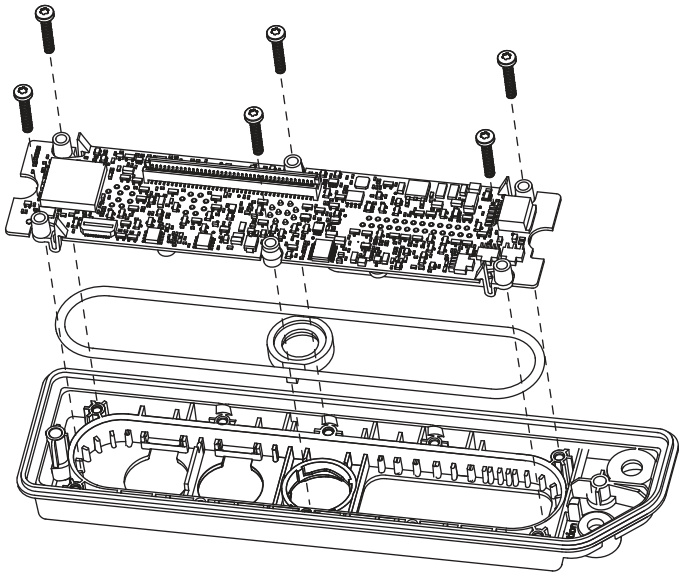


Figure 138: Front Panel Reassembly for High-Power Model



8.1.18
Radio Disassembly

This section describes the disassembly of your radio.

8.1.18.1

APX 5500/APX 6500/APX 7500/APX 6500Li Mid Power Models

CAUTION: Steps 1 through 6 MUST be performed, prior to removal of the Controller and RF Board from the chassis. Otherwise damage to the transceiver Controller Board could occur.

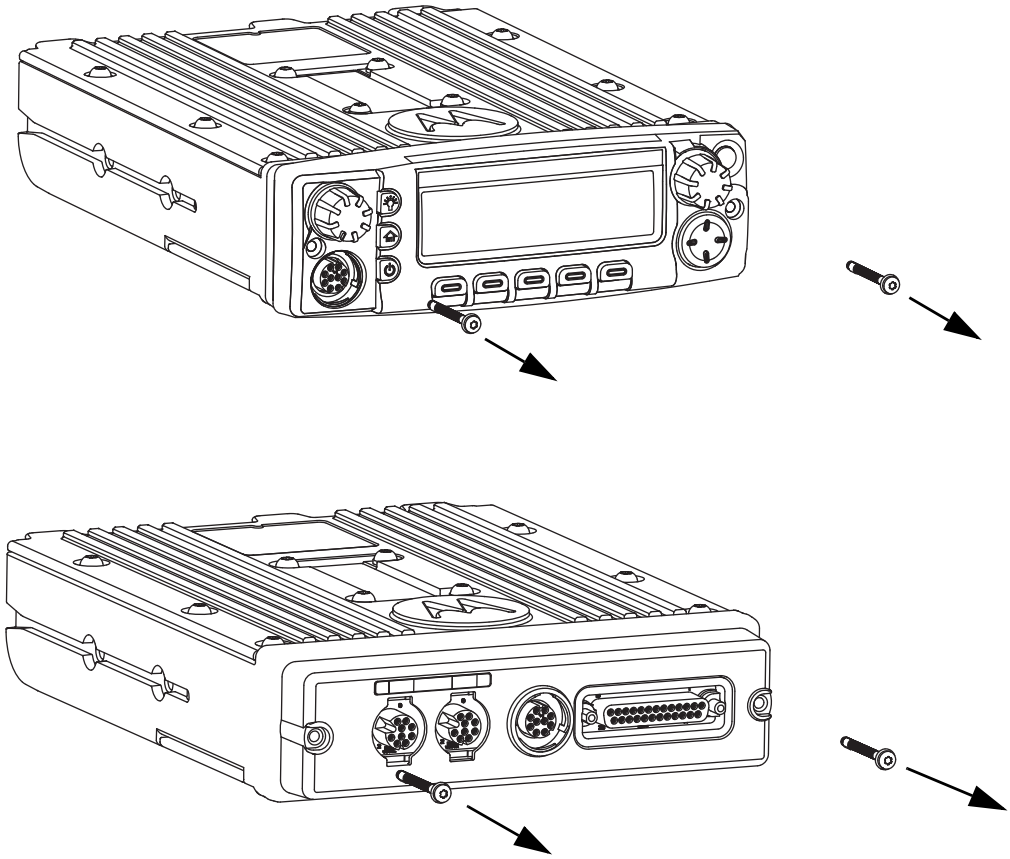
Procedure:

1 Ensure all accessory connections, power, antenna, and microphone are unplugged.

If radio is in remote mount configuration, disconnect the remote-mount control cable (CAN cable) from the transceiver.

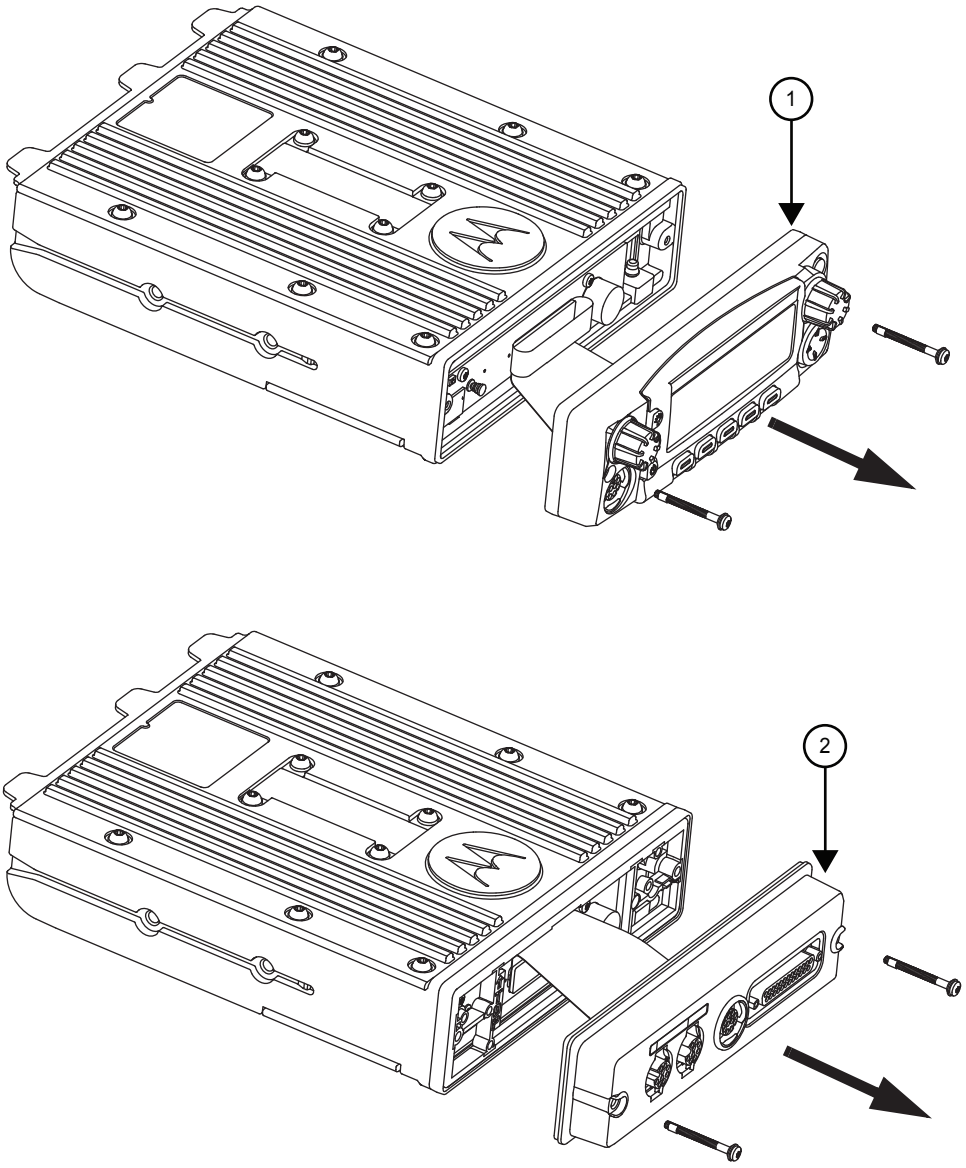
2 Remove the two (2) front control head/TIB screws using a T-10 torx bit, do not discard screws.

Figure 139: Removing the Control Head Screws



3 Firmly grasp the control head/transceiver interface board (TIB) front housing and frame seal, and carefully remove from the radio. Be careful not to pull the attached flex, to avoid option board damage during control head/TIB removal.

Figure 140: Removing the Control Head/TIB



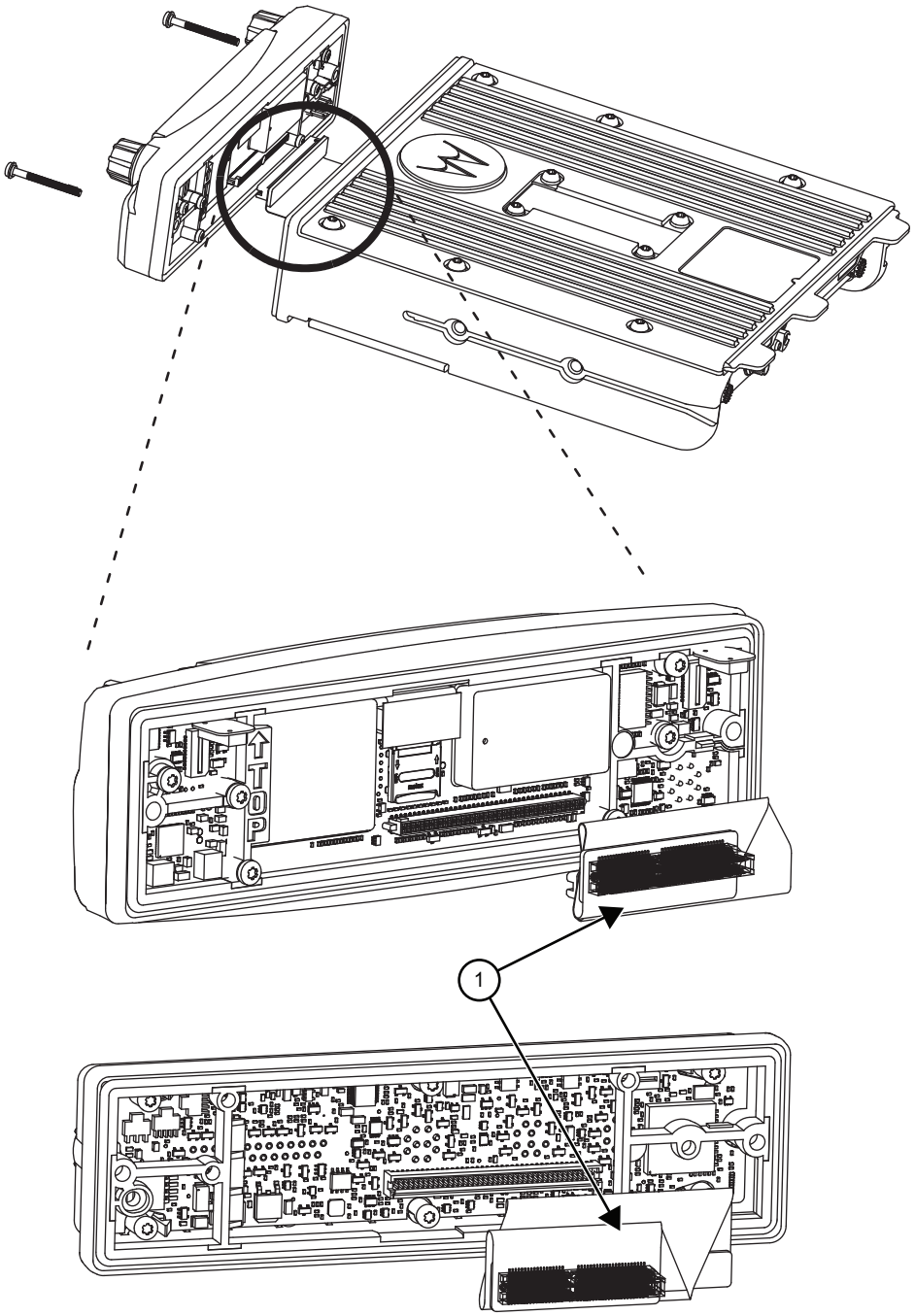
1	Control Head
2	TIB

4 Lay the control head or TIB face down on a clean, flat surface, being careful not to scratch or mar the face of the display.

5 Carefully disconnect control head/TIB flex from transceiver's edge card.

NOTE: "Carefully" means that the control head flex shall be disconnected from its mating control head connector by applying equal amounts of pressure on both ends of the mated pair until they fully disconnect. While disconnecting, make sure both mated pairs are pulled apart in a straight-forward [or "in-line"] direction parallel to the longitudinal axis of the connector pins.

Figure 141: Removing the Control Head Flex

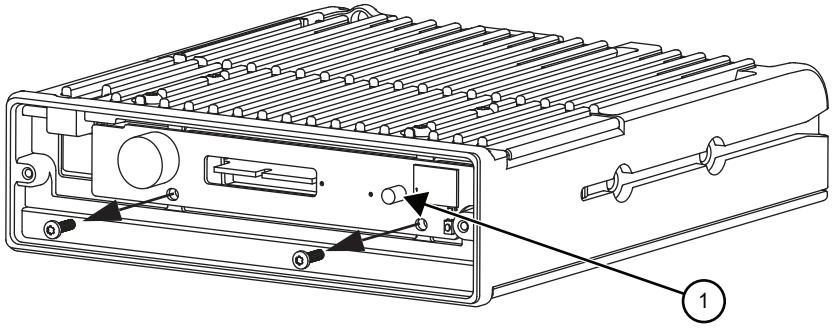


1	Control Head Flex

CAUTION: The following steps MUST be performed for option board equipped radios, prior to removal of the Controller or RF board from chassis. Otherwise damage to Controller or RF boards could occur.

6 If Option Board is not present, skip to step 7. Remove the two option board screws using a T-10 torx bit. Do not discard screws.

Figure 142: Removing the Option Board Screws

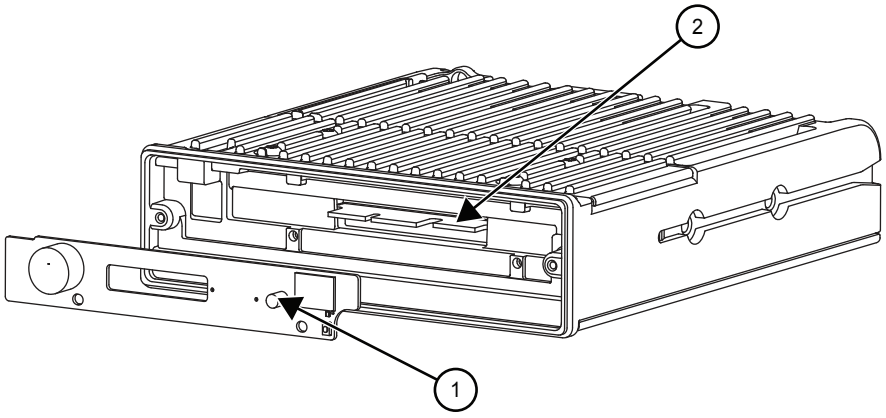


1	Option Board Handle

7 Carefully remove option board from transceiver's edge card using the option board handle.

CAUTION: Do not remove WLAN port plug.

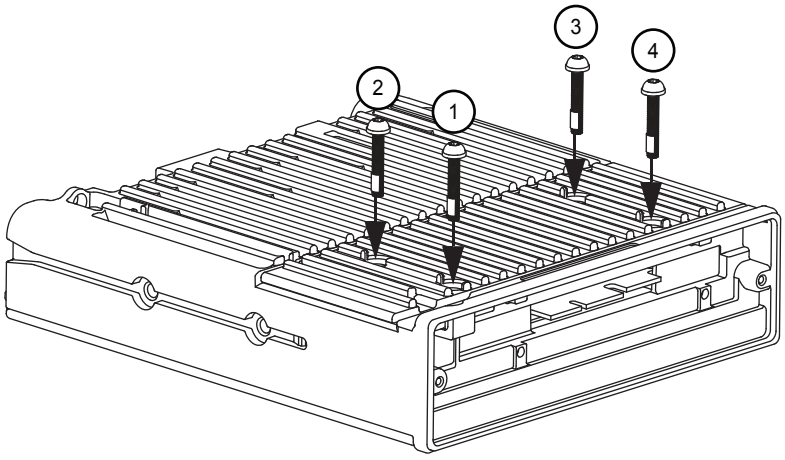
Figure 143: Removing the Option Board



1	Option Board
	WLAN Port Plug (recessed at bottom of radio)

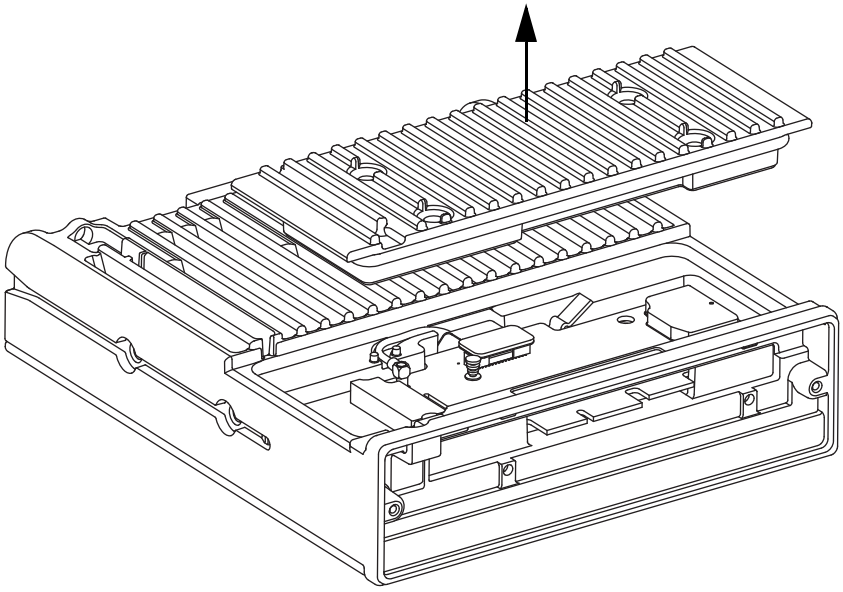
8 Radio must be oriented as shown below with the bottom of the radio facing up. Remove the four (4) controller cover screws using a T-20 torx bit. These screws have sealing washers that should be kept with the screw. Do not discard screws.

Figure 144: Removing the Controller Cover Screws



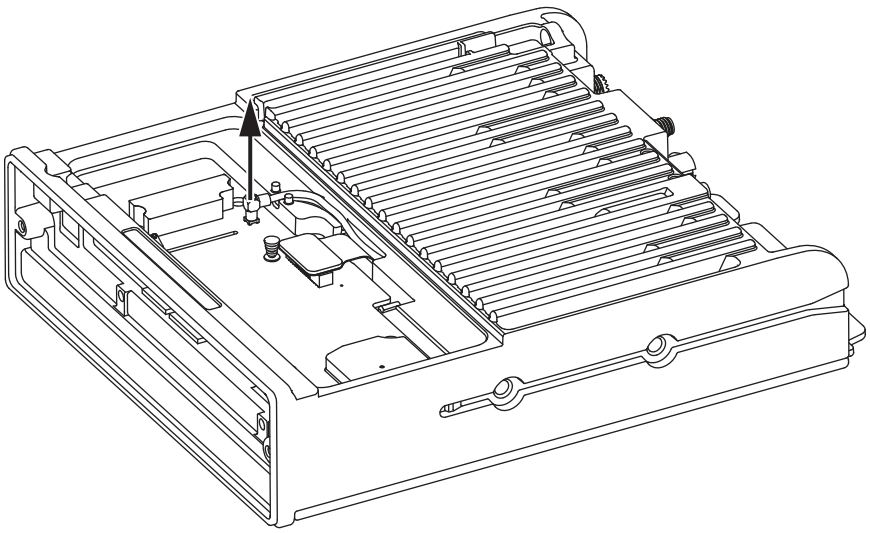
9 Remove the controller cover by lifting up simultaneously on both side edges. It may be necessary to gently pry the cover off using a plastic tool. Be sure to remove the controller cover seal. Do not discard seal.

Figure 145: Lifting the Controller Cover



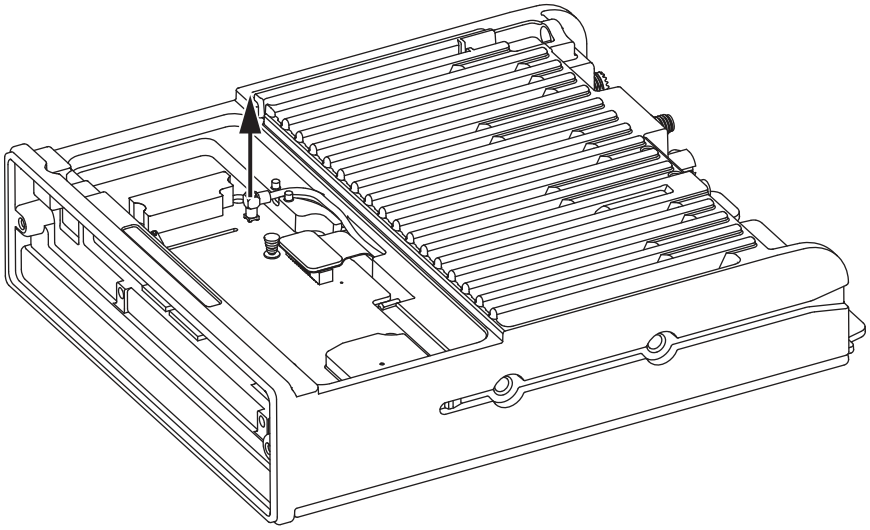
10 Disconnect the GPS cable from the controller board by gently holding the controller board in place and pulling up on the GPS cable's MMCX connector. Do not pull on the cable section of the GPS cable as damage may occur. Avoid contact with exposed thermal grease on controller board, thermal grease may be removed with a dry lint-free cloth.

Figure 146: Disconnecting the GPS Cable



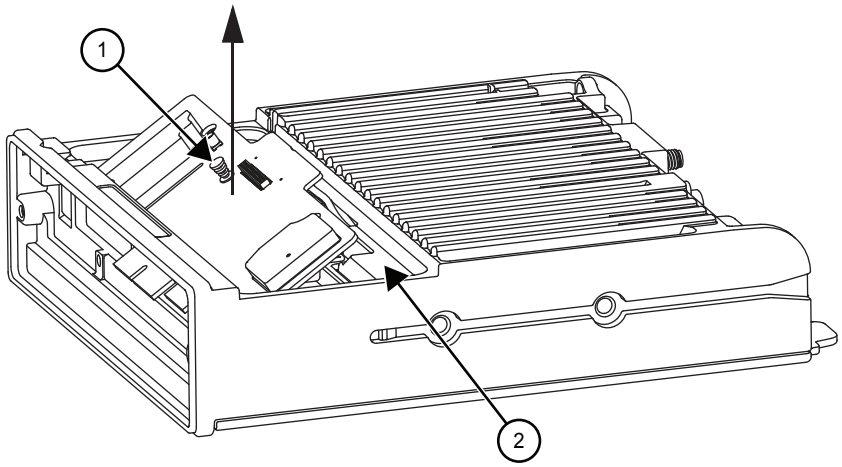
11 Disconnect the rear accessory flex from the controller board.

Figure 147: Removing the J2 Rear Accessory Flex from the Controller Board



12 Disconnect the controller board from the RF board by inserting a plastic tool into the controller board disengagement slot and gently prying controller board up.

Figure 148: Removing the Controller Board

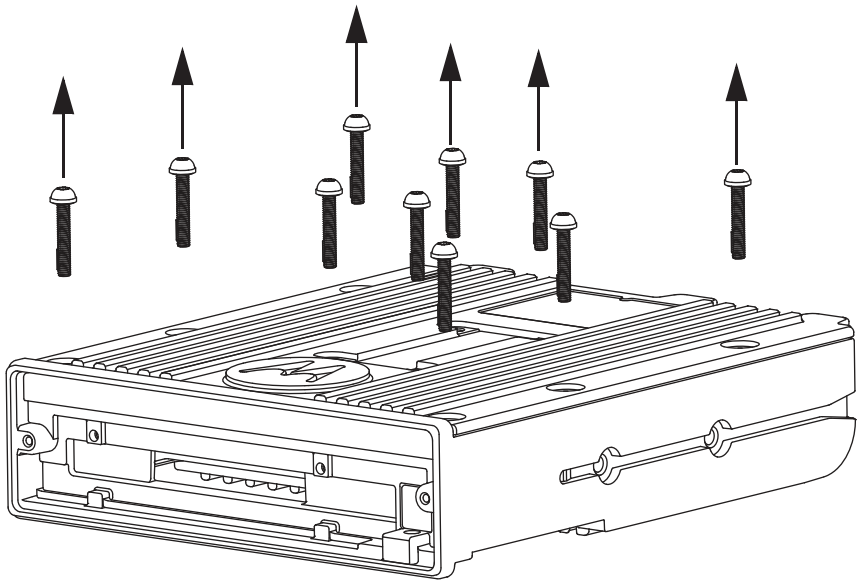


1	Controller Handle
2	Controller Board Disengagement Slot

13 Remove the controller board from the chassis using the controller board handle. The controller board needs to be tilted forward and pulled back and out of the chassis to avoid damage to the controller board edge card. Hold the controller board by the handle or edges only, and store in an anti-static bag.

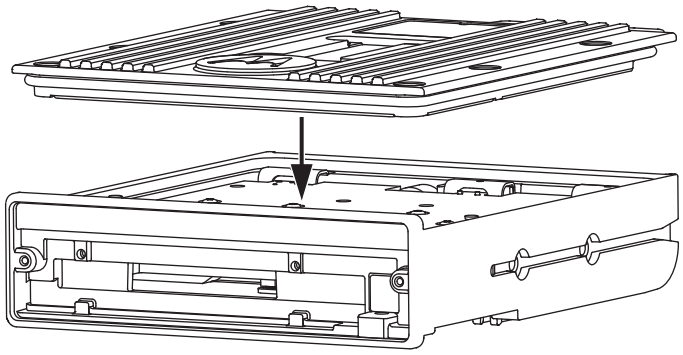
14 FLIP RADIO OVER: remove the ten (10) RF cover screws using a T-20 torx bit. These screws have sealing washers that should be kept with the screw. Do not discard screws.

Figure 149: Removing the RF Cover Screws



15 Remove the RF cover by lifting up simultaneously on both side edges. It may be necessary to gently pry the cover off using a plastic tool. Be sure to remove the RFcover seal. Do not discard seal.

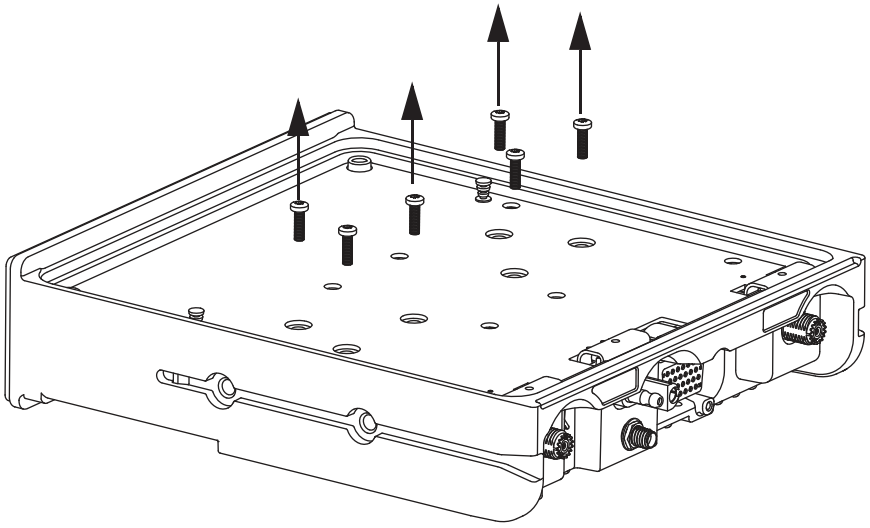
Figure 150: Lifting the RF Cover



CAUTION: The PA screws must be removed BEFORE the RF/DC retention clips or damage will occur to the RF board.

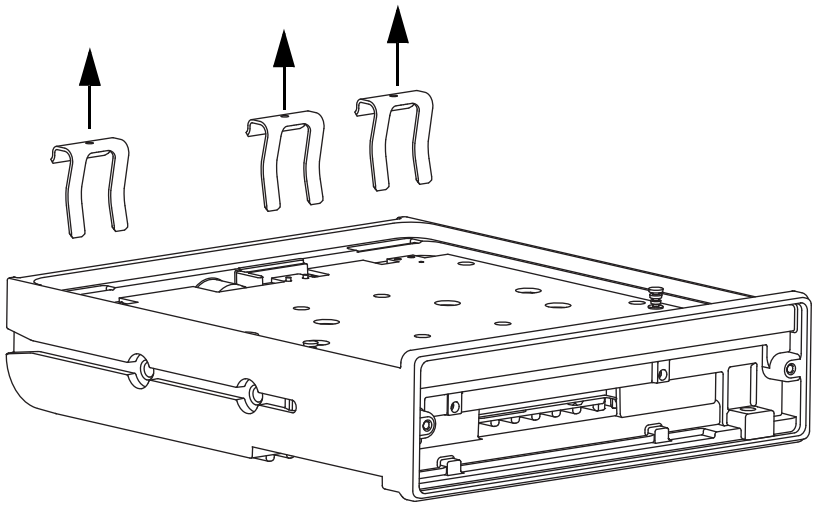
16 Remove all PA screws (3 screws for single band radios, 6 screws for dual band radios) using a T-10 torx bit. Be careful while handling PA screws as there may be residual thermal grease on the threads.

Figure 151: Removing the PA Screws



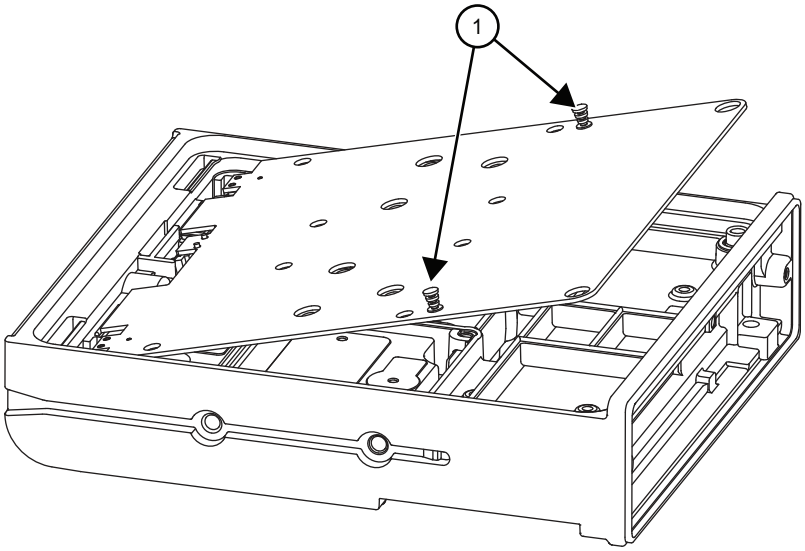
17 Remove the 3 RF/DC retention clips by gently prying them out with a flat-blade screwdriver. For leverage, use only the chassis, do not use the PCB or any of its components.

Figure 152: Removing the RF/DC Retention Clips



18 Remove the RF board by gently pulling up on the 2 RF board handles to disengage the RF board locating features and RF/DC seals. Then slide the RF board towards the front of the chassis and swing the board up and out. Handle the RF board by the 2 handles or edges only, and store in an anti-static bag. Avoid contact with exposed thermal grease on RF board, thermal grease may be removed with a dry lint-free cloth.

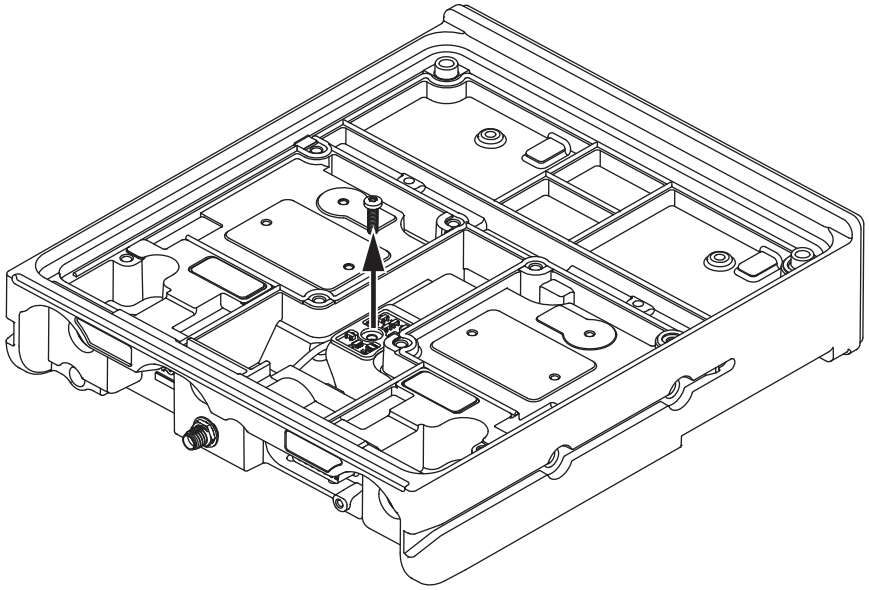
Figure 153: Removing the RF Board



1	RF Board Handle

19 Remove the accessory flex screw using a T-10 torx bit.

Figure 154: Removing the J2 Rear Accessory Connector Internal Screw



20 Remove the 2 rear accessory connector screws using a T-10 torx bit. The rear accessory screws have a washer and seal that need to remain assembled onto the screw. Do not discard screws.

Figure 155: Removing the J2 Rear Accessory Connector External Screws

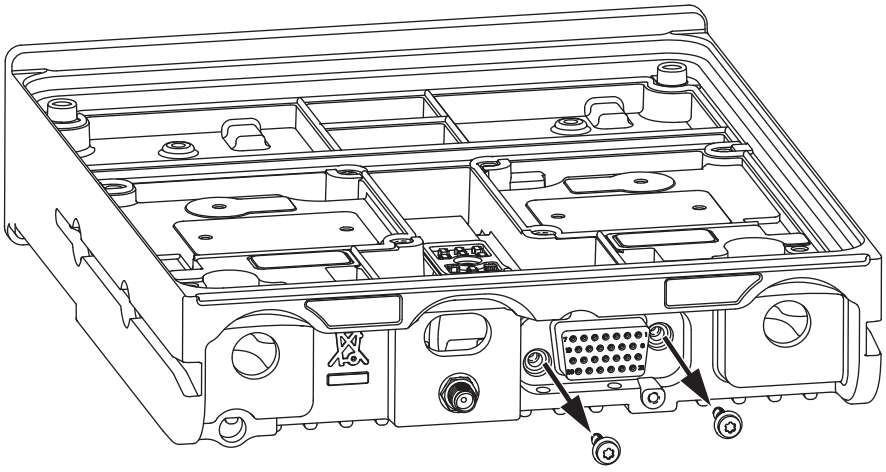
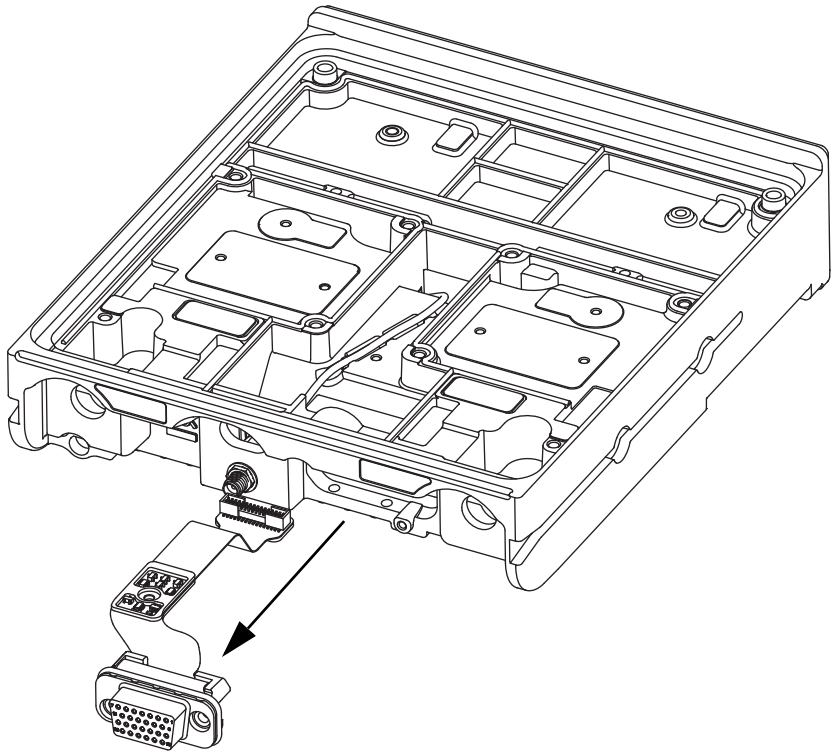
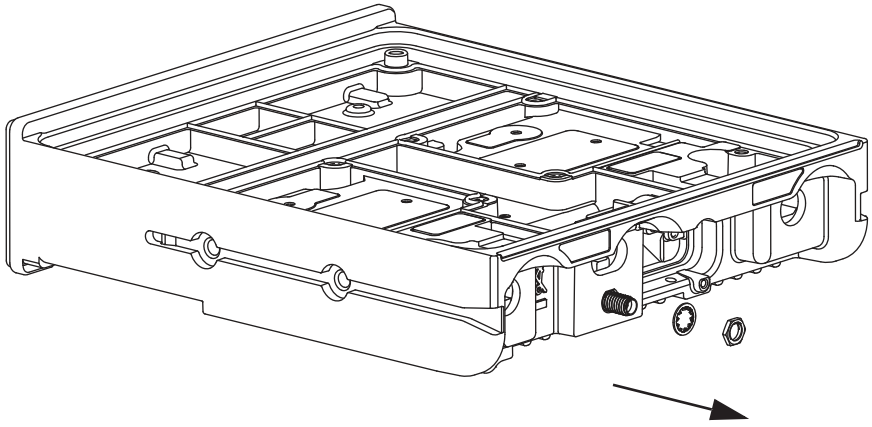


Figure 156: Removing the J2 Rear Accessory Connector



21 Remove GPS SMA connector nut using a deep 5/16” socket or deep nut driver. Remove the GPS SMA connector lock washer. Do not discard nut or lock washer.

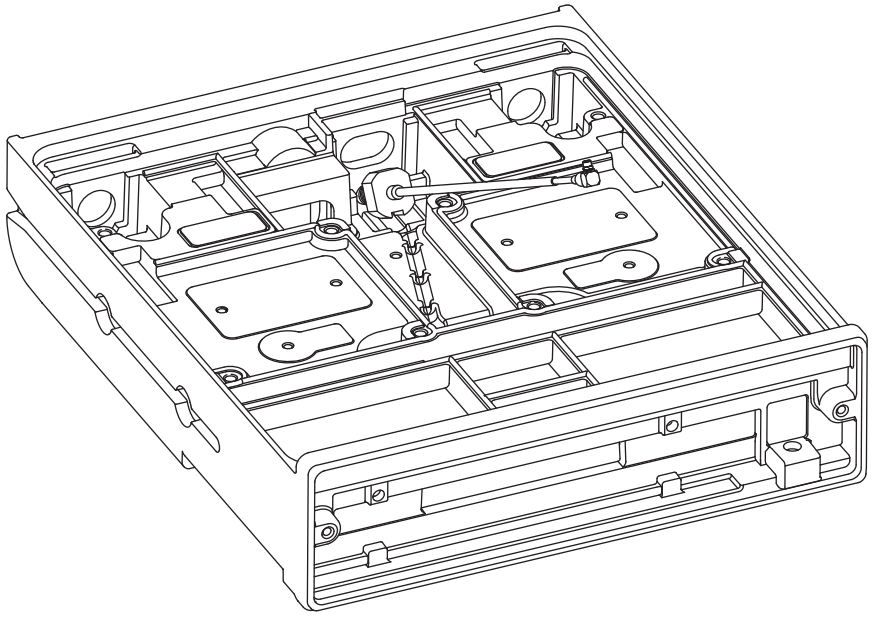
Figure 157: Removing the GPS Cable Nut



22 Gently remove GPS cable from chassis retention channel (on opposite side of chassis) and pull cable through controller/RF chassis opening. Cable should now be entirely on top of the radio. Gently pull the GPS cable ferrule towards the front of the radio and lift cable out of the chassis.

NOTE: There is an o-ring on the internal portion of the threaded portion of the GPS ferrule. Reassemble the lock washer and nut onto the GPS to hold the o-ring in place.

Figure 158: Removing the GPS Cable



8.1.18.2

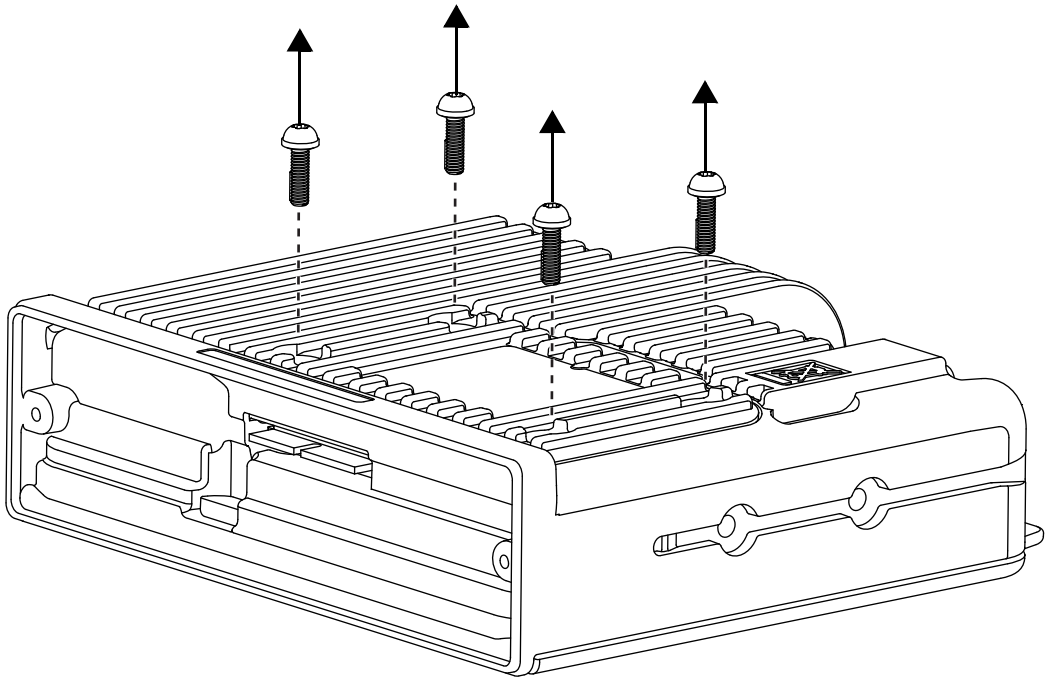
Disassembling the Radio

Use the following procedures to disassemble your radio:

Procedure:

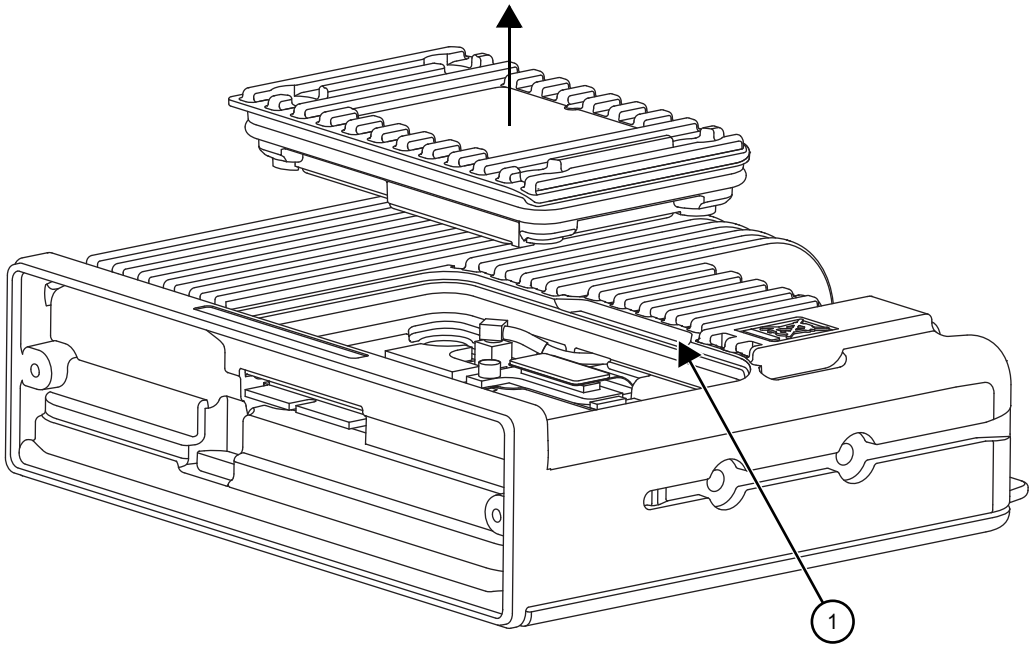
1. Ensure that all accessories connections, power, antenna, and microphone are unplugged. If radio is in remote mount configuration, disconnect the remote-mount control cable (CAN cable) from the radio.
2. Remove the front control head or TIB screws using an appropriate bit by referring to the steps explained in 8.2.16.4 for O2 Control Head, 8.2.16.5 for O7 Control Head, and 8.2.16.6 for TIB. Do not discard the screws.
3. After removing the control head or TIB, the radio must be oriented as shown in the following figure with the bottom of the radio facing up. Remove the four (4) bottom cover screws using a T-20 torx bit. These screws have sealing washers, which should be kept with the screw. Do not discard the screws.

Figure 159: Removing the Bottom Cover Screws



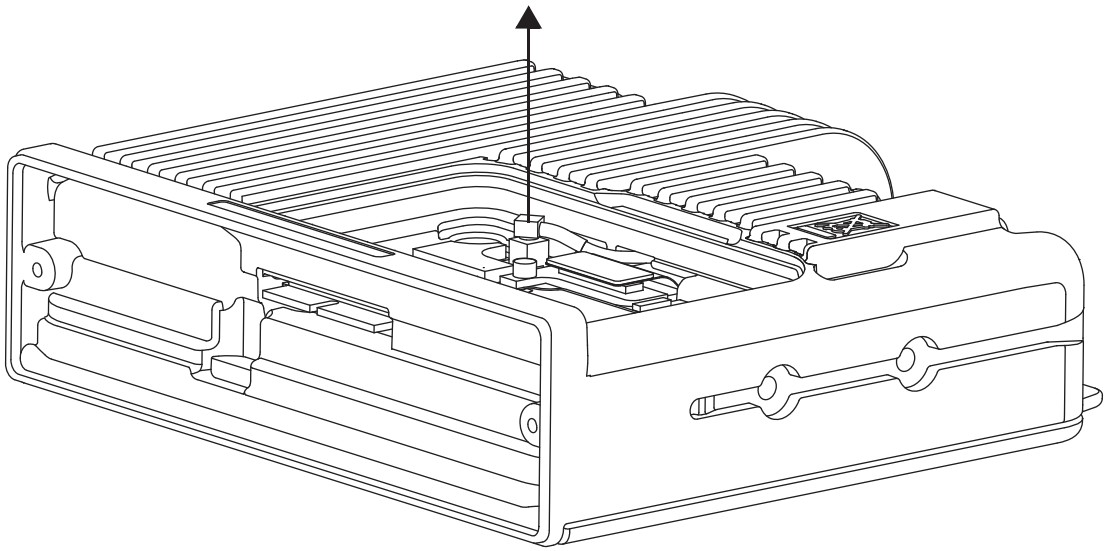
4 Remove the bottom cover from the disengagement slot on the main chassis. Hold both sides of the bottom cover, and lift it gently. It may be necessary to gently pry the cover off using a plastic tool. Be sure to remove the bottom cover seal. Do not discard the seal.

Figure 160: Removing the Bottom Cover



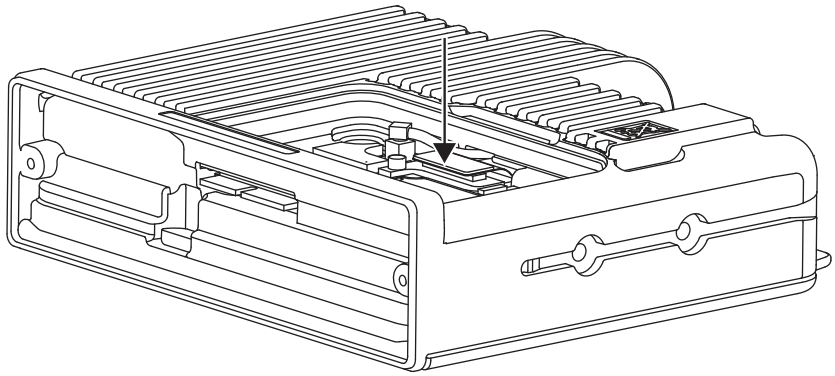
5 Disconnect the GPS cable from the controller board by gently holding the controller board in place and pulling up the GPS cable's MMCX connector. Do not pull the GPS cable, as damage may occur.

Figure 161: Disconnecting the GPS Cable



6 Disconnect the rear accessory flex from controller board.

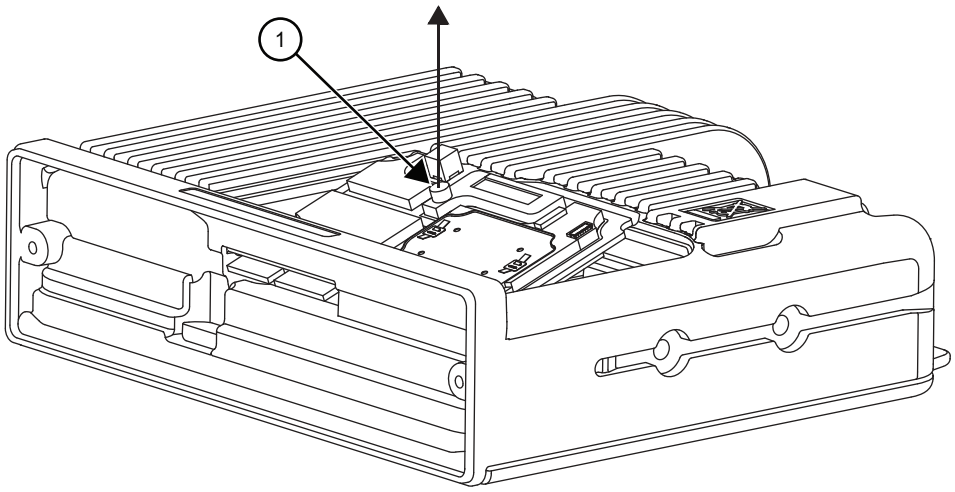
Figure 162: Disconnecting the Rear Accessory Flex



7 Disconnect the controller board from the RF board by tilting it upward from the core, out from the front chassis, and gently lift it with the handle.

8 Use the controller board handle to remove the controller board from the chassis. The controller board needs to be tilted forward, pulled back and out from the chassis, to avoid damage to the controller board edge card. Hold the controller board on the handle or edges only, and store it in an antistatic bag.

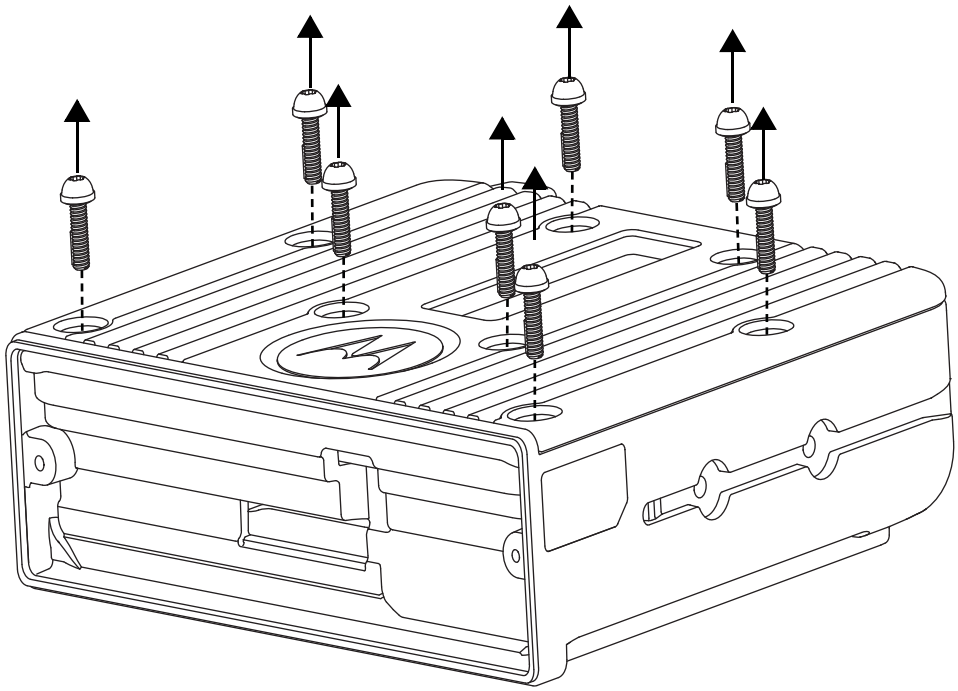
Figure 163: Removing the Controller Board



9 Flip the radio over.

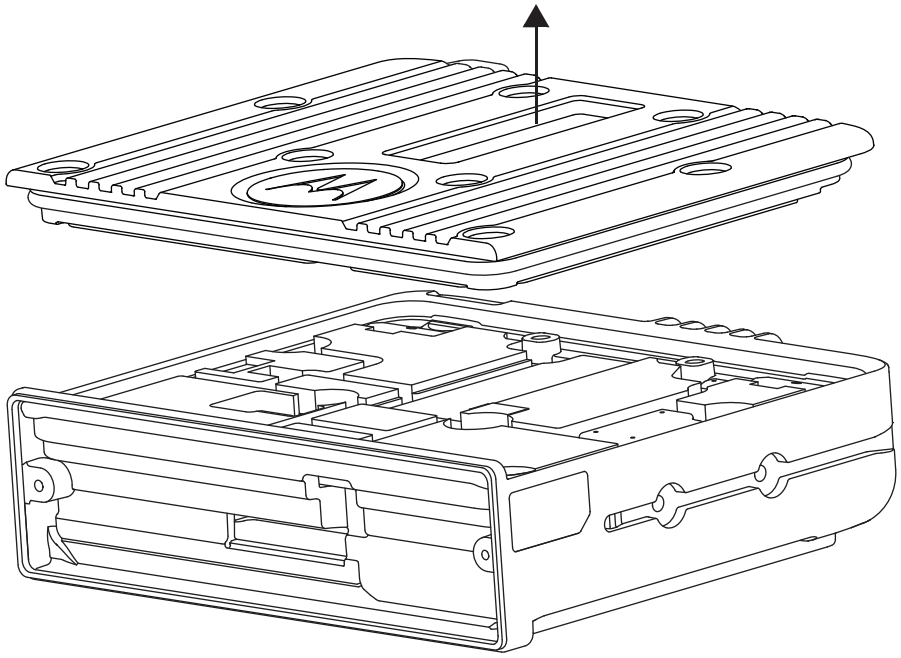
10 Remove the eight (8) top cover screws using a T-20 torx bit. These screws have sealing washers that should be kept with the screws. Do not discard the screws.

Figure 164: Removing the Top Cover Screws



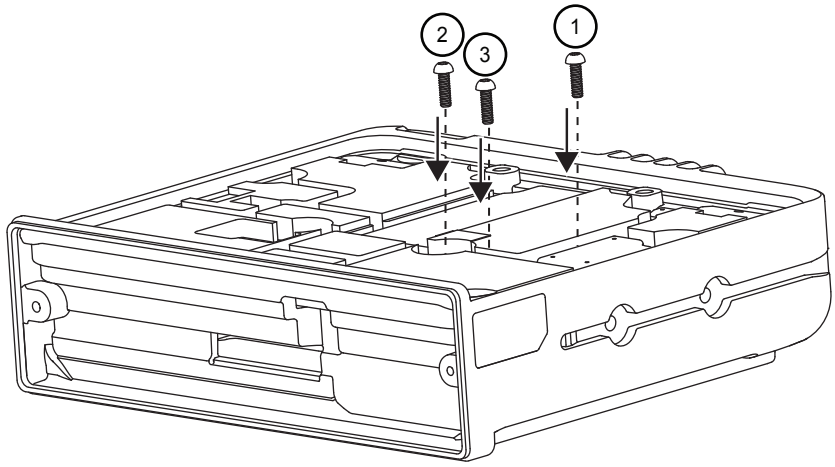
11 Remove the top cover with assistance of a plastic tool (6686119B01), and lift both side edges of the cover simultaneously. It may be necessary to gently pry off the cover using the plastic tool. Be sure to remove the top cover seal. Do not discard the seal.

Figure 165: Removing the RF Cover



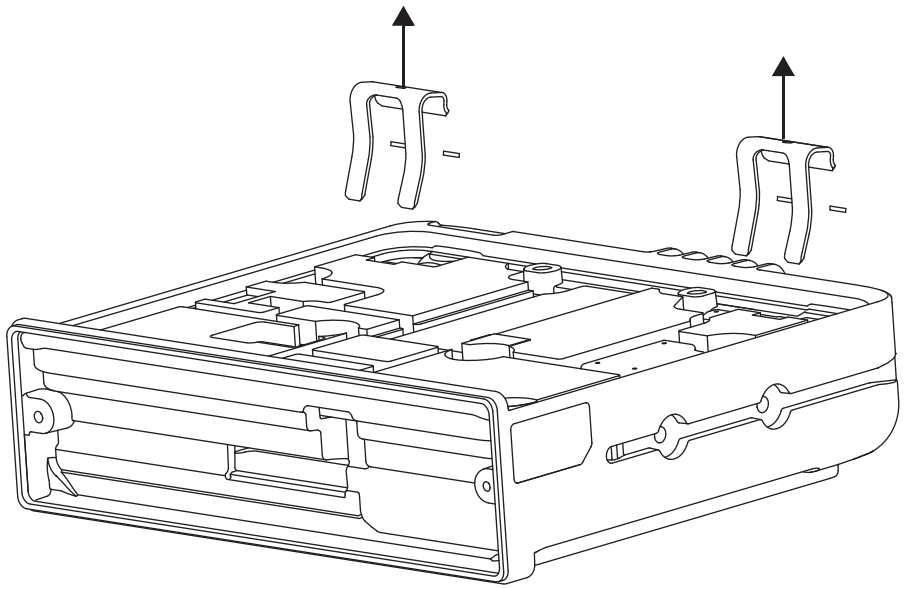
12 Remove three (3) PA screws using a T-10 torx bit. Be careful while handling PA screws as there may be residual thermal grease on threads.

Figure 166: Removing the PA Screws



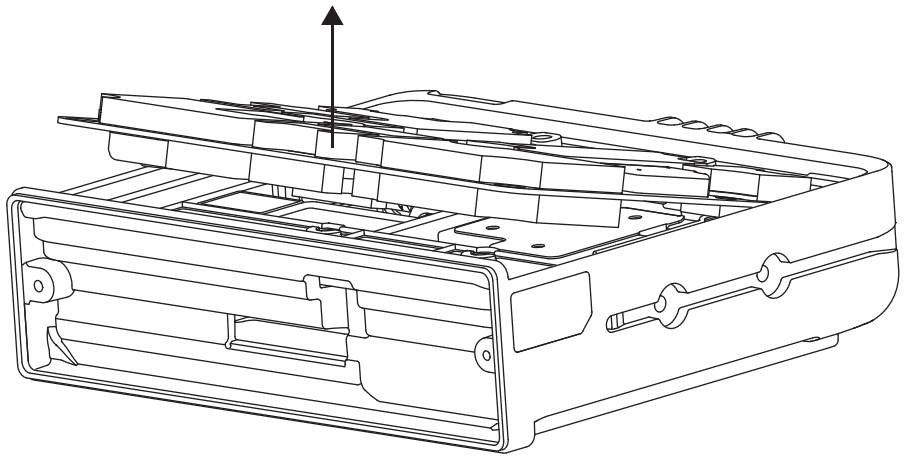
13 Remove the two (2) RF/DC retention clips by gently prying them out with a flat-blade screwdriver. For leverage, use only the chassis, do not use the PCB or any of its components.

Figure 167: Removing the RF/DC Retention Clips



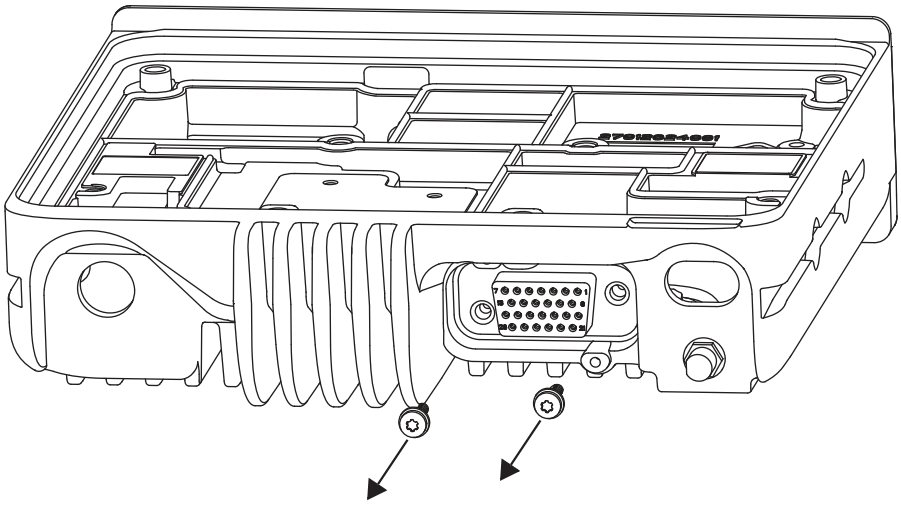
14 Remove the RF board by gently pushing it upwards, and removing it from the front chassis. Then slide the RF board towards the front of the chassis, and swing the board up and out. Hold the RF board on the edges, and store it in an antistatic bag. Avoid contact with the exposed thermal grease on the RF board, and it may be removed with a dry lint-free cloth.

Figure 168: Removing the RF Board



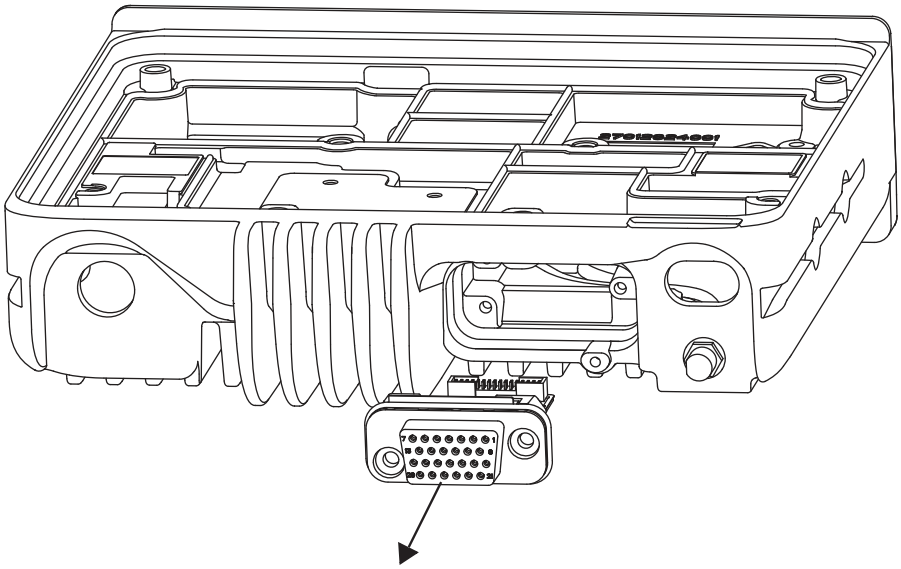
15 Remove the two (2) rear accessory connector screws using a T-10 torx bit. The rear accessory screws have a washer and seal, that needs to be remained assemble on the screw. Do not discard the screws.

Figure 169: Removing the Rear Accessory Connector screws



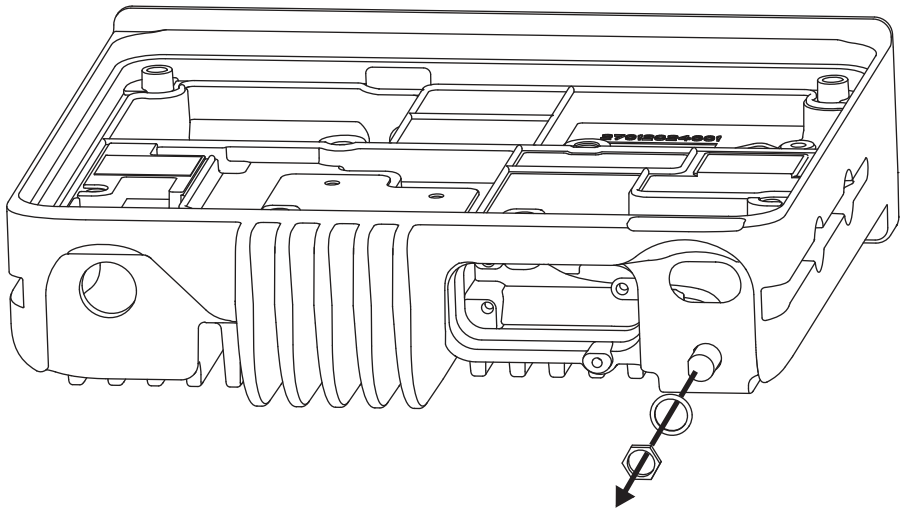
16 Gently remove the rear connector flex from the chassis, through the rear connector chassis opening.

Figure 170: Removing the Rear Connector Flex



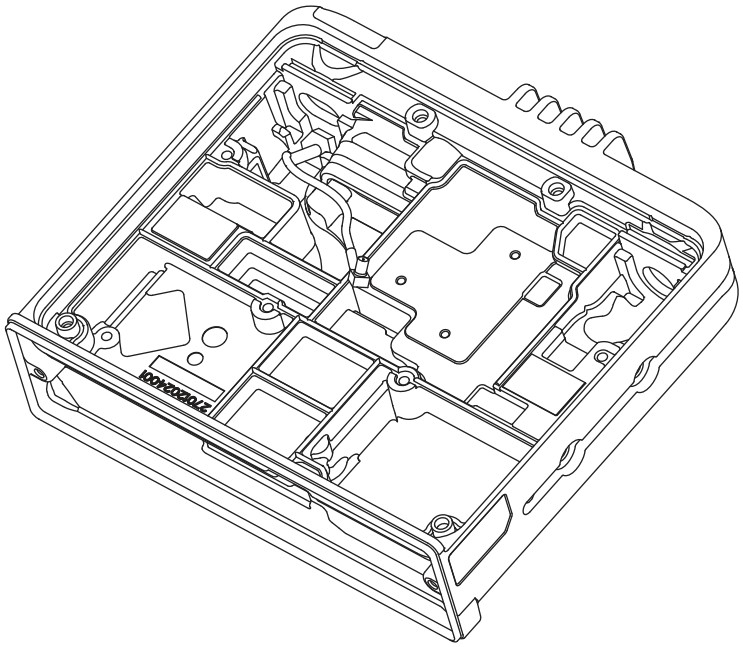
17 Remove the GPS SMA connector nut using a deep 5/16” socket or deep nut driver. Remove the GPS SMA connector lock washer. Do not discard the nut or lock washer.

Figure 171: Removing the GPS SMA Connector



18 Gently remove the GPS cable from the chassis retention channel, which is on the opposite side of the chassis, and pull the cable through the controller/RF chassis opening. The cable should now be entirely on top of the radio. Pull the GPS cable ferrule to the front of radio, and lift the cable out from the chassis.

Figure 172: Removing the GPS Cable



NOTE: There is an o-ring on the internal threaded portion of the GPS ferrule. Reassemble the lock washer and nut onto the GPS to hold the o-ring in place.

8.1.18.3

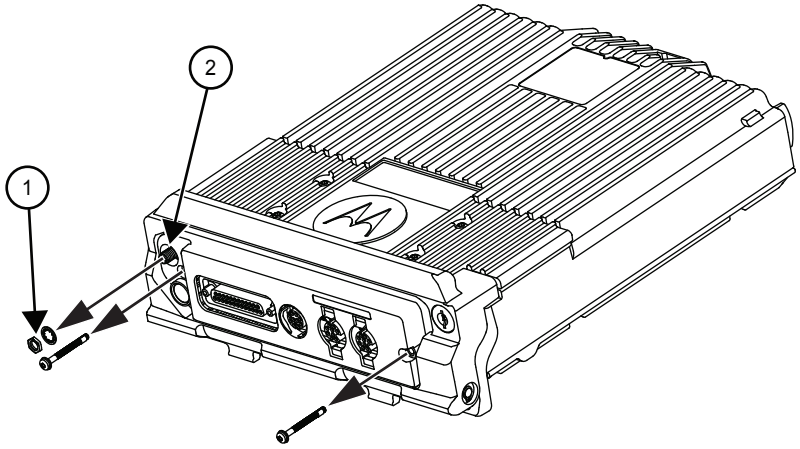
High Power Models

CAUTION: Steps 1 through 4 MUST be performed, prior to removal of the Controller and RF Board from the chassis. Otherwise damage to the transceiver Controller Board could occur.

Procedure:

1 Ensure all accessory connections, power, antenna, and microphone are unplugged. Remove the two screws that secure the Transceiver Interface Board (TIB) housing using a T10 Torx bit. Also remove the GPS nut and washer using a “5/16” socket. Save for later use.

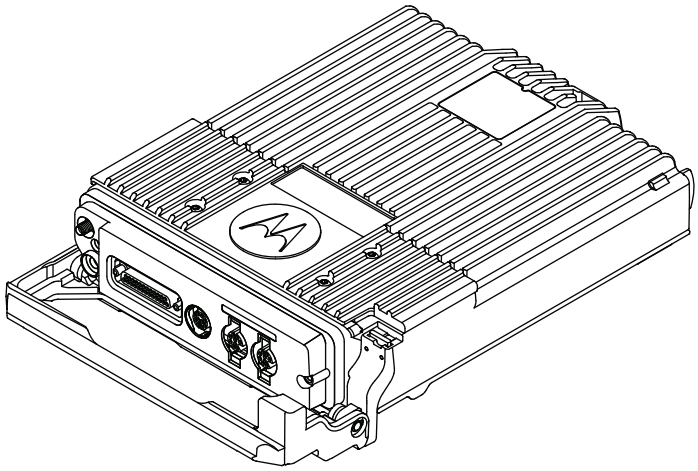
Figure 173: Removing the Transceiver Interface Board Screws



1	Removing the nut requires a deep 5/16” socket with thin walls.
2	SMA Connector

2 Remove the front panel by gently pulling the housing so that it disengages from the chassis. Be careful not to pull the attached flex as the housing is being removed.

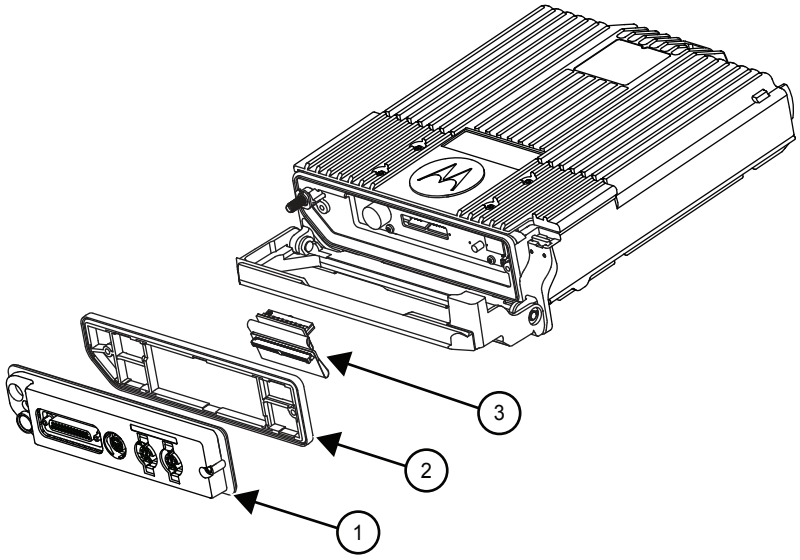
Figure 174: Removing the Transceiver Interface Board Assembly



3 Carefully disconnect the flex from the TIB and the transceiver, and set the panel aside on a clean, flat surface. The Seal Frame may still be attached to the chassis. Remove it and keep with the TIB.

NOTE: "Carefully" means that the control head flex shall be disconnected from its mating control head connector by applying equal amounts of pressure on both ends of the mated pair until they fully disconnect. While disconnecting, make sure both mated pairs are pulled apart in a straight-forward [or "in-line"] direction parallel to the longitudinal axis [or "in direction of arrow"] of the connector pins.

Figure 175: Removing the Flex (Transceiver Interface Board Connector)



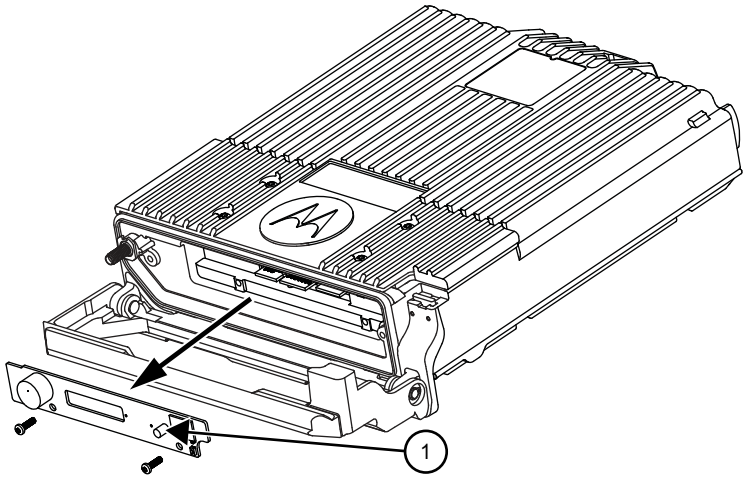
1	TIB
2	Seal Frame
3	Flex

4 For option-equipped radios, do the following before disassembly of the transceiver.

a Remove the two screws holding the option board in place.

b Grab the Small Handle on the option board, and gently pull the option board away from the chassis.

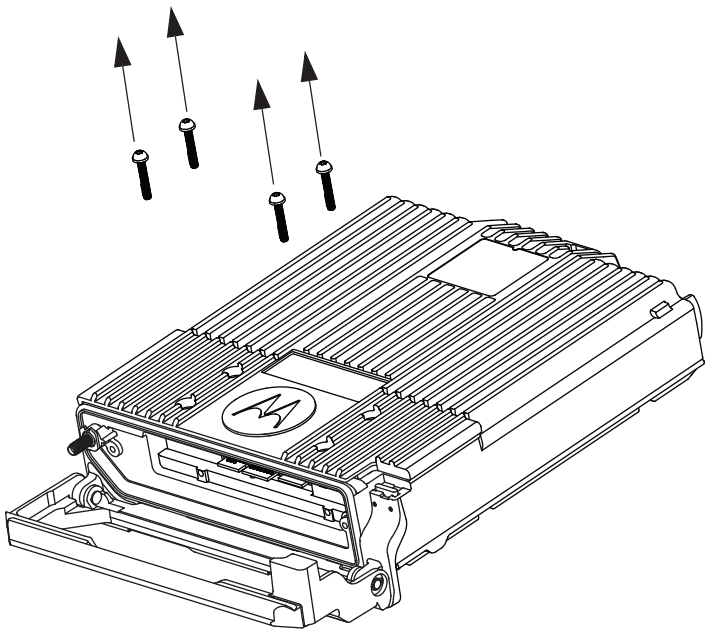
Figure 176: Removing the Option Board



1	Option Board Handle

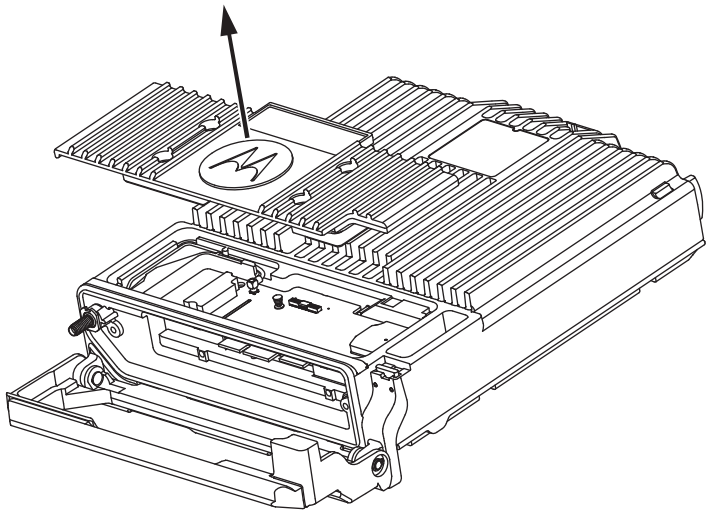
5 Remove the four (4) controller cover screws using a T-20 torx bit. These screws have sealing washers that should be kept with the screw. Do not discard screws.

Figure 177: Removing the Controller Cover Screws



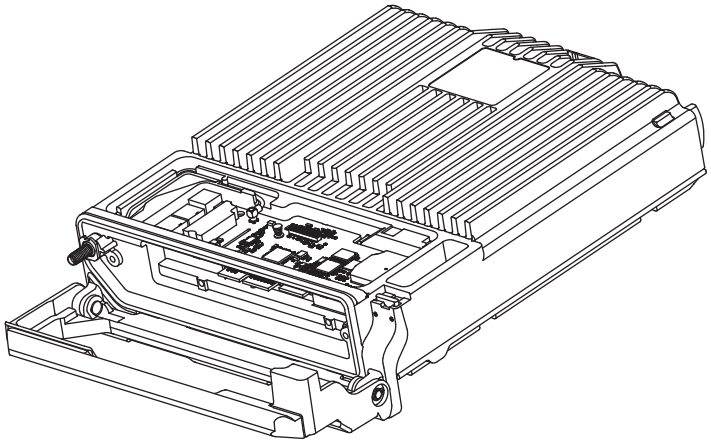
6 Remove the controller cover by lifting up simultaneously on both side edges. It may be necessary to gently pry the cover off using a plastic tool. Be sure to remove the controller cover seal. Do not discard seal.

Figure 178: Lifting the Controller Cover



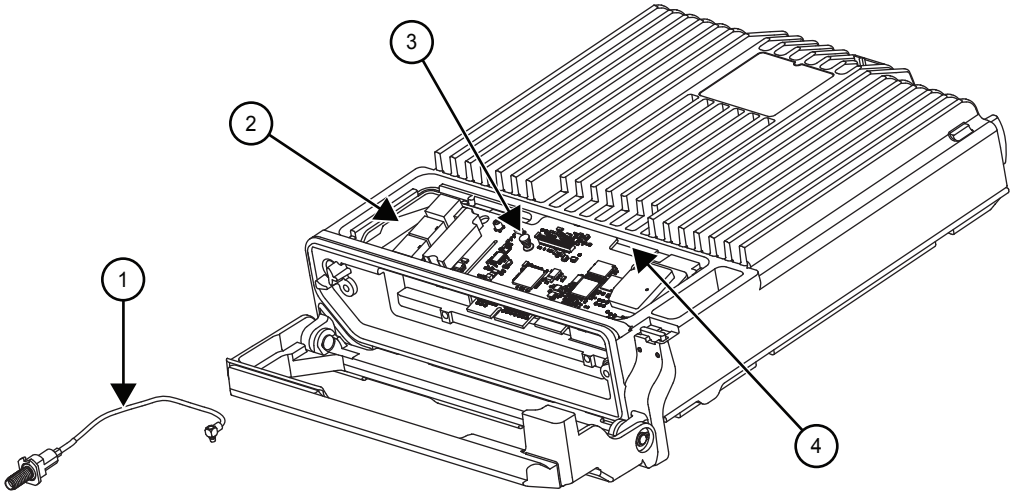
7 Disconnect the GPS cable from the controller board by gently holding the controller board in place and pulling up on the GPS cable's MMCX connector. Do not pull on the cable section of the GPS cable as damage may occur.

Figure 179: Controller Cover Removed



8 Disconnect the controller board from the RF board by inserting a plastic tool into the controller board disengagement slot and gently prying controller board up. Remove the controller board from the chassis using the controller board handle. The controller board needs to be tilted forward and pulled back and out of the chassis to avoid damage to the controller board edge card. Handle the controller board by the handle or edges only, and store in an anti-static bag. Remove the GPS cable from the pinch points and gently pull out of the front of the radio.

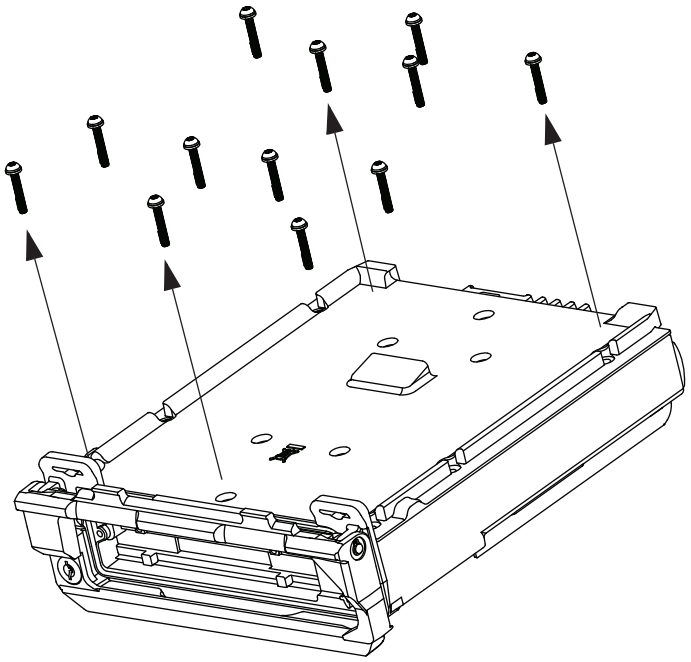
Figure 180: Removing the Controller Board



1	GPS Cable
2	Controller Board
3	Controller Board Handle
4	Disengagement Slot

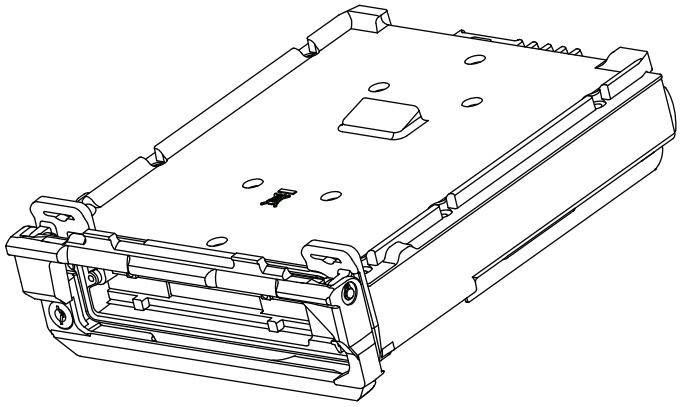
9 FLIP THE RADIO OVER: Remove the 12 RF cover screws using a Torx T20 bit. These screws have sealing washers that should be kept with the screw. Do not discard screws.

Figure 181: Removing the RF Cover Screws



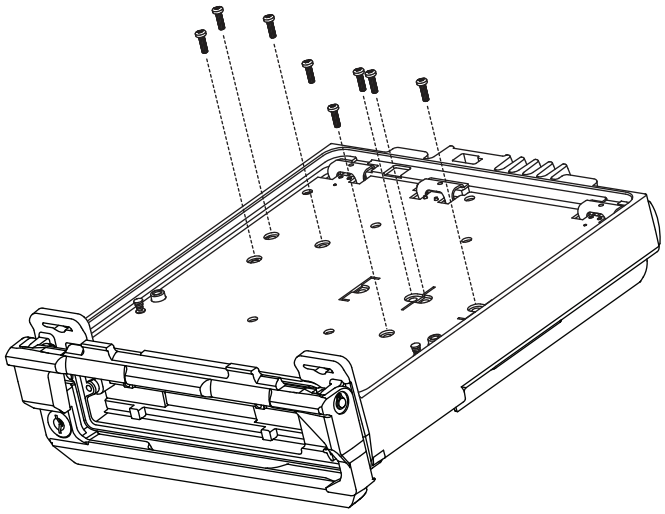
10 Remove the RF cover by lifting up simultaneously on both side edges. It may be necessary to gently pry the cover off using a plastic tool.

Figure 182: Lifting the RF Cover



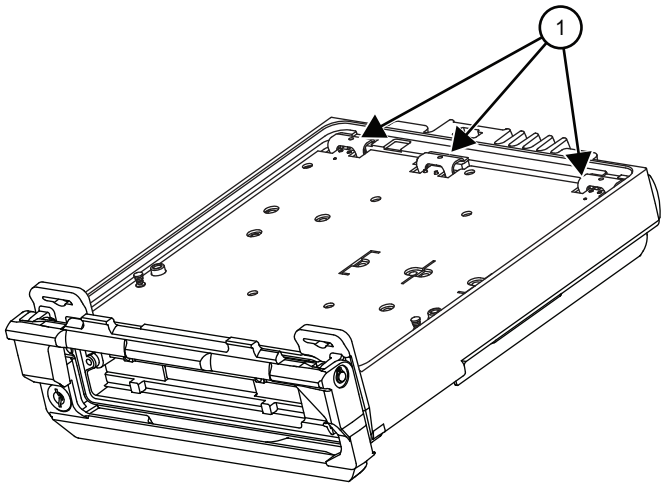
11 Remove the PA screws shown using a Torx T10 bit (up to 10 screws).

Figure 183: Removing the PA Screws (MP/HP Configuration Shown)



12 Remove the 3 RF/DC retention clips by gently prying them out with a flat-blade screwdriver. For leverage, use only the chassis, do not use the PCB or any of its components.

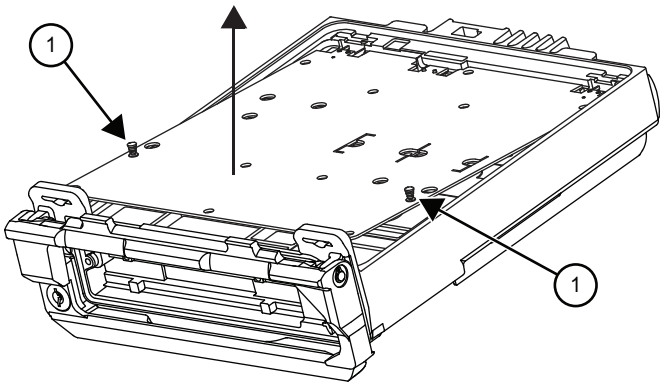
Figure 184: Removing the RF/DC Retention Clips



1	RF/DC Retention Clips

13 Remove the main board by pulling on the two handles on the side of the RF PCB.

Figure 185: Pushing Up the Main Board



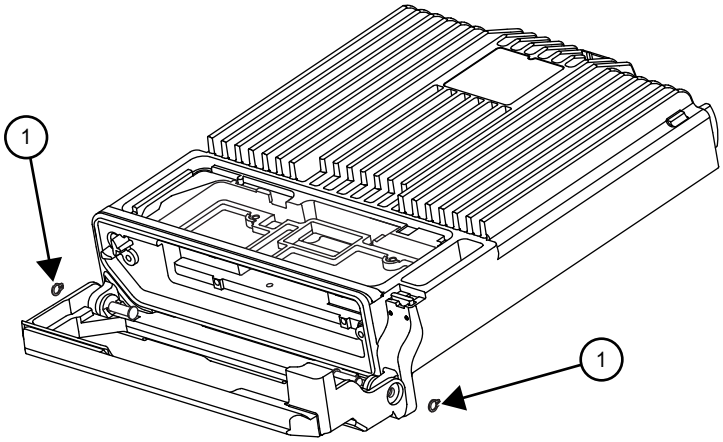
1	RF PCB Handle

14 Then, slide the main board towards the front of the chassis. Lift it out of the chassis. Handle the main board by the edges only, and store it in an antistatic bag.

15 If Handle Removal is needed; remove the pivot pin clip using a snap ring pliers on the outside of the handle and push the pivot pin towards the middle of the radio, repeat on other side of the handle.

NOTE: TIB housing must be removed to disassemble radio handle.

Figure 186: Removing the Pivot Pin Clip



1	Pivot Pin Clip

8.1.18.4

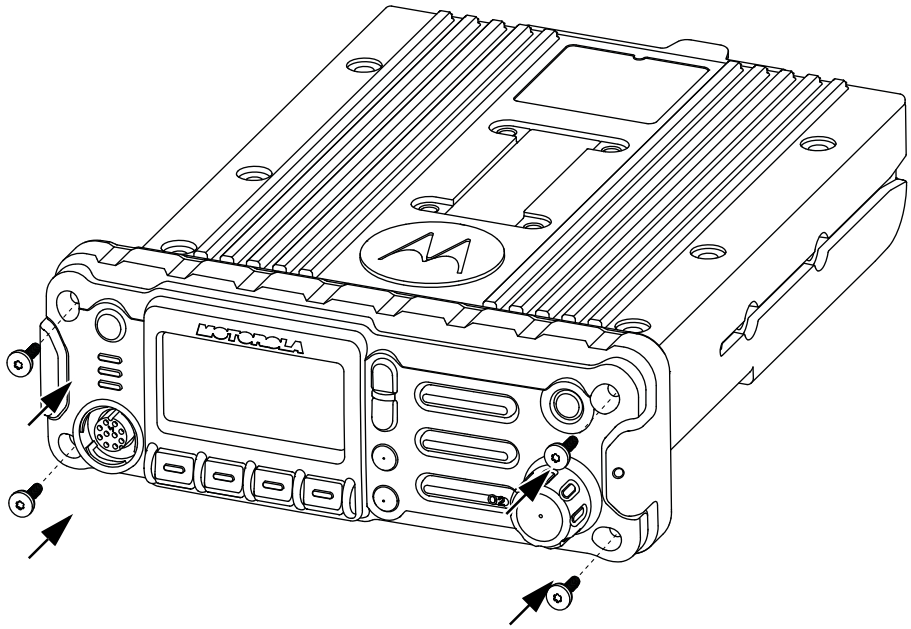
Disassembling the O2 Control Head

Procedure:

1 Ensure that the power, antenna, microphone and all accessory connections are unplugged. If the radio is a remote-mount radio, disconnect the remote-mount control cable from the front of the transceiver.

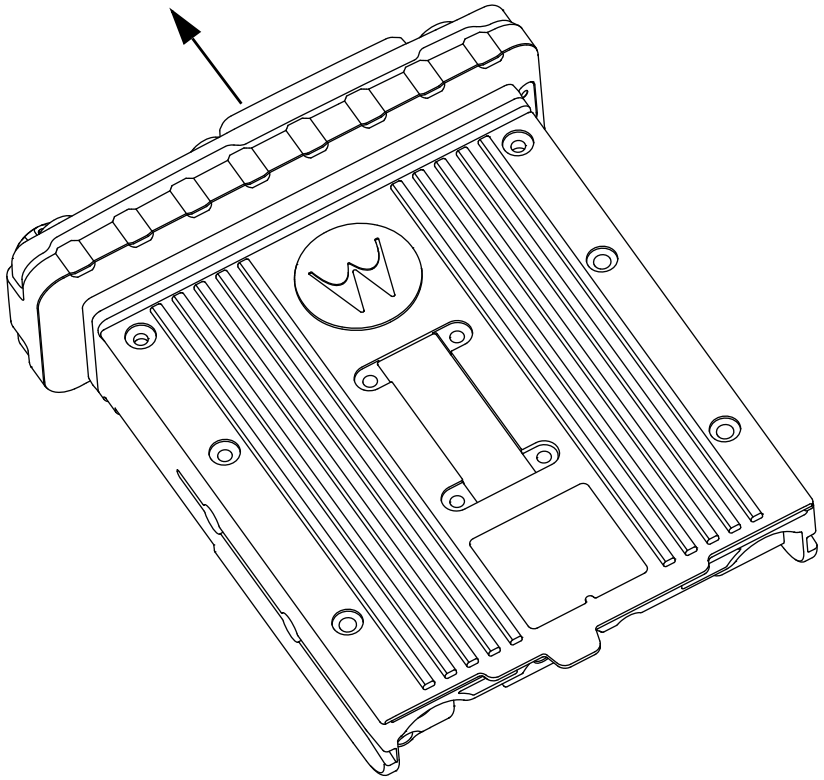
2 Remove the four front control head screws using a T20 torx bit and discard them.

Figure 187: Removing the Control Head Screws



3 Firmly grasp the front panel of the control head or the Transceiver Interface Board (TIB) for remote mount, and carefully remove the front housing assembly from the back housing assembly. Be careful not to pull the attached flex.

Figure 188: Removing the Control Head

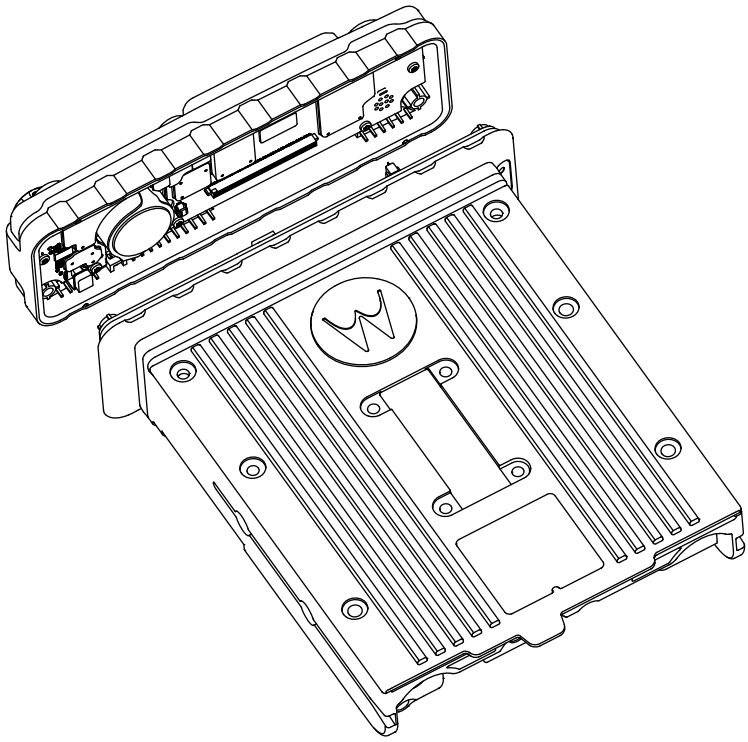


4 Lay the control head or the TIB face down on a clean, flat surface, being careful not to scratch or mar the surface of the display.

5 Carefully disconnect the transceiver flex from the front housing assembly or TIB and set the front housing assembly or TIB aside.

NOTE: The O2/O7 knob removal tool can be used as a lever to simplify the task of disconnecting the transceiver flex and reduce the risk of damaging the connectors.

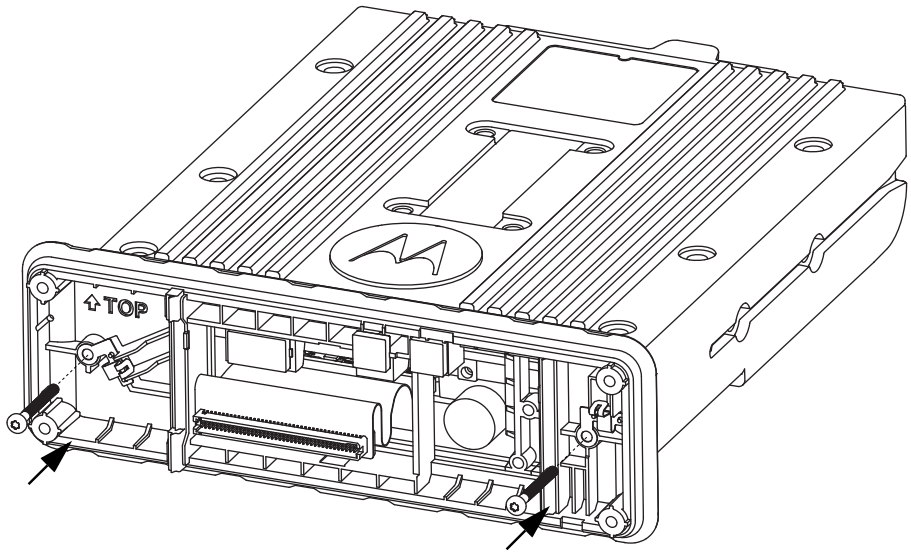
Figure 189: Disconnecting the Transceiver Flex from the Front Housing Assembly



6 Remove the two transceiver screws using a T10 torx bit and pull the back housing assembly away from the transceiver. Do not reuse the transceiver screws.

NOTE: Be careful to avoid pulling on the flex.

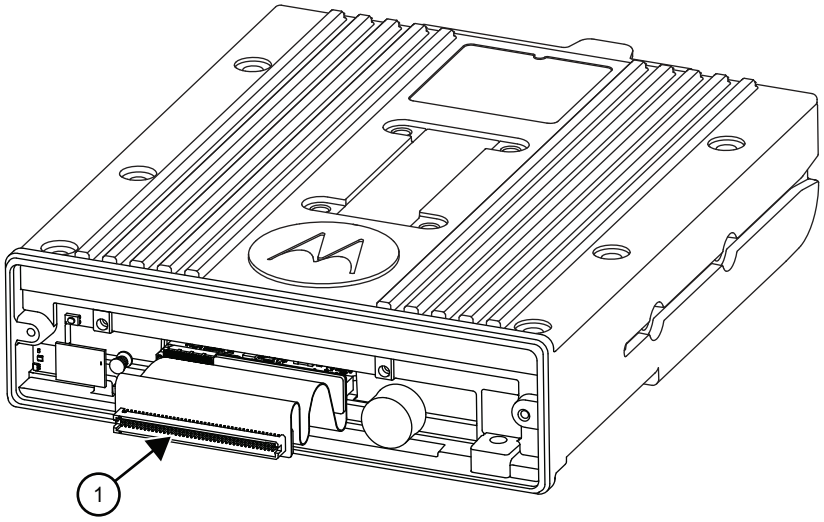
Figure 190: Removing the Back Housing Assembly



7 Carefully separate the I-seal, from the back housing assembly.

8 Carefully remove the transceiver flex from the transceiver by grasping the provided handle and separating it from the connector.

Figure 191: Removing the Transceiver Flex



1	Transceiver Flex

8.1.18.5

Disassembling the O5 Control Head

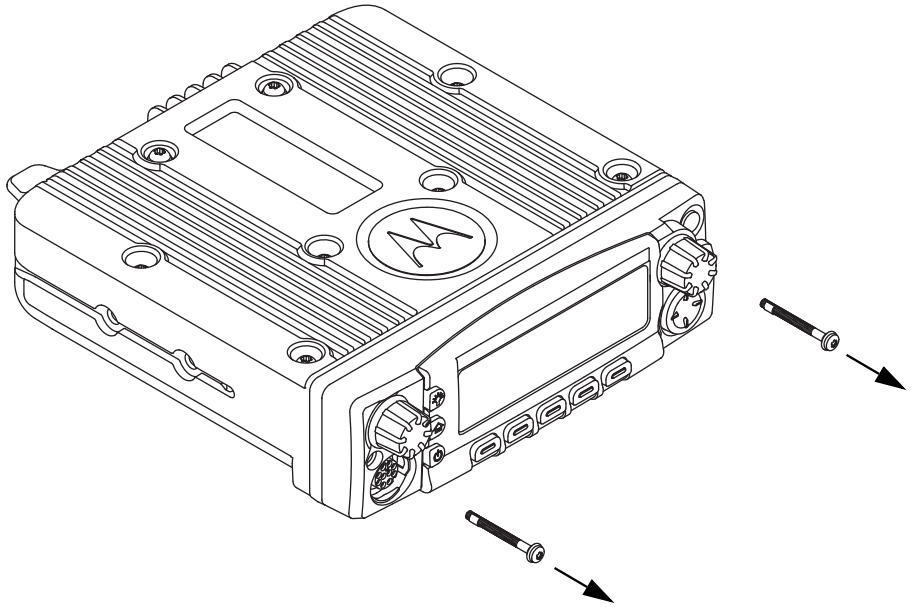
Procedure:

1 Ensure that all accessory connections, power, antenna, and microphone are unplugged.

If the radio is in remote mount configuration, disconnect the remote-mount control cable (CAN cable) from the transceiver.

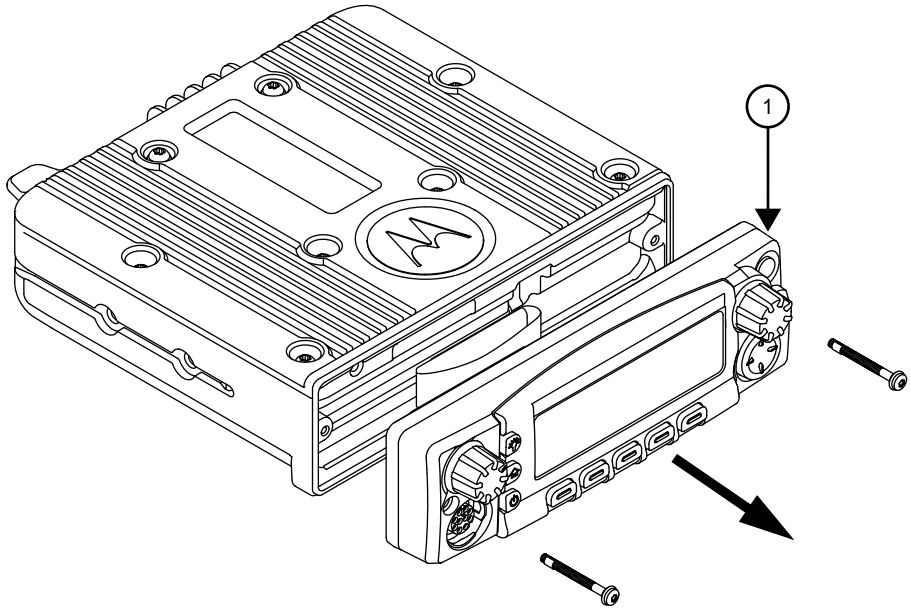
2 Remove the two (2) front control head/TIB screws using a T-10 torx bit, do not discard the screws.

Figure 192: Removing the Control Head Screws



3 Firmly grasp the control head/transceiver interface board (TIB) front housing and frame seal, and carefully remove it from the radio. Be careful not to pull the attached flex, during control head/TIB removal.

Figure 193: Removing the Control Head/TIB



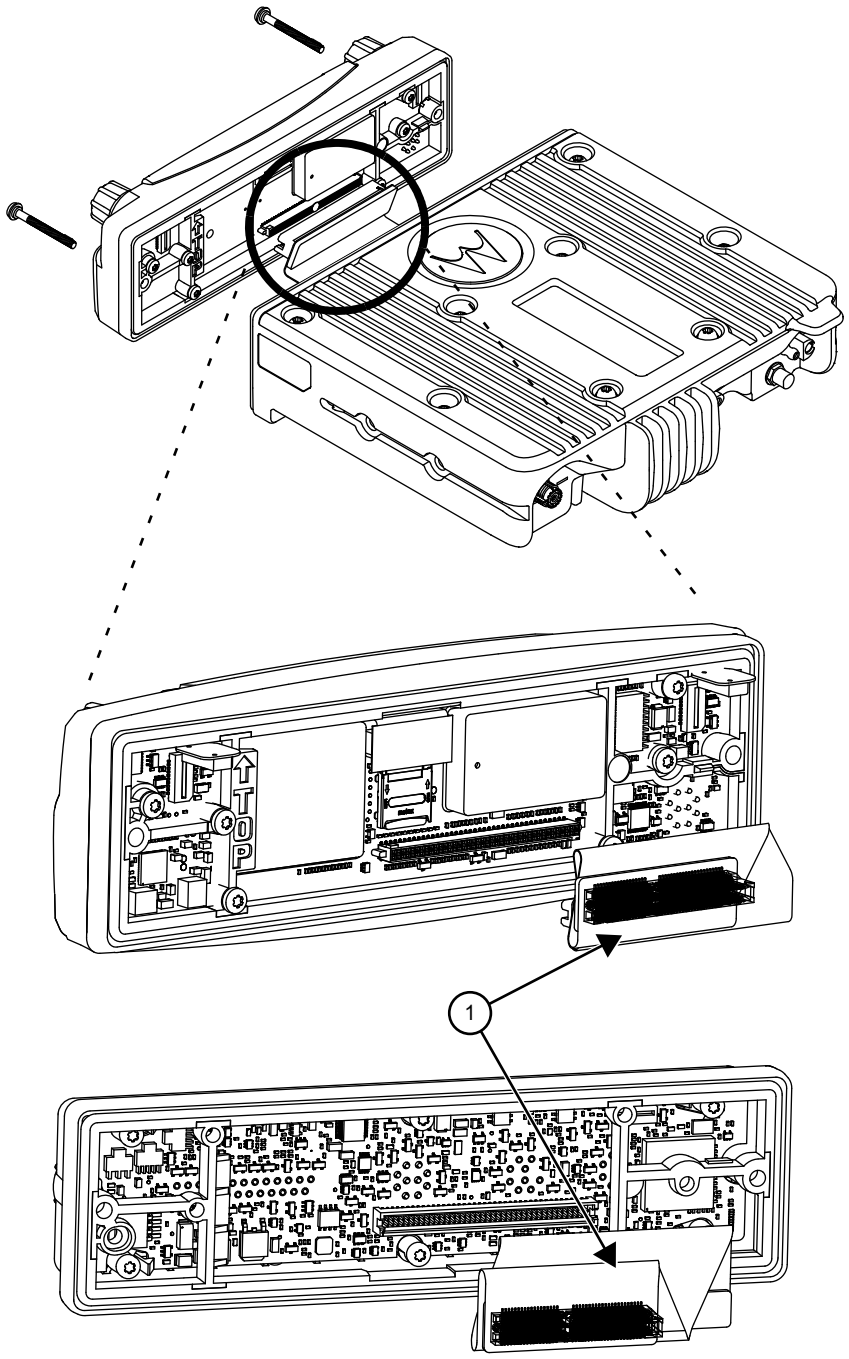
1	Control Head

4 Lay the control head or TIB face down on a clean, flat surface, being careful not to scratch or mar the face of the display.

5 Carefully disconnect the control head/TIB flex from transceiver's edge card.

NOTE: "Carefully" means that the control head flex shall be disconnected from its mating control head connector by applying equal amounts of pressure on both ends of the mated pair until they fully disconnect. While disconnecting, make sure both mated pairs are pulled apart in a straight-forward or in-line direction parallel to the longitudinal axis of the connector pins.

Figure 194: Removing the Control Head Flex



1	Control Head Flex

8.1.18.6

Disassembling the O7 Control Head

Procedure:

1. Ensure that the power, antenna, microphone and all accessory connections are unplugged. If the radio is a remote-mount radio, disconnect the remote-mount control cable from the front of the transceiver.
2. Remove the two transceiver screws using a T10 torx bit and discard them.

   Figure 195: Removing the Transceiver Screws

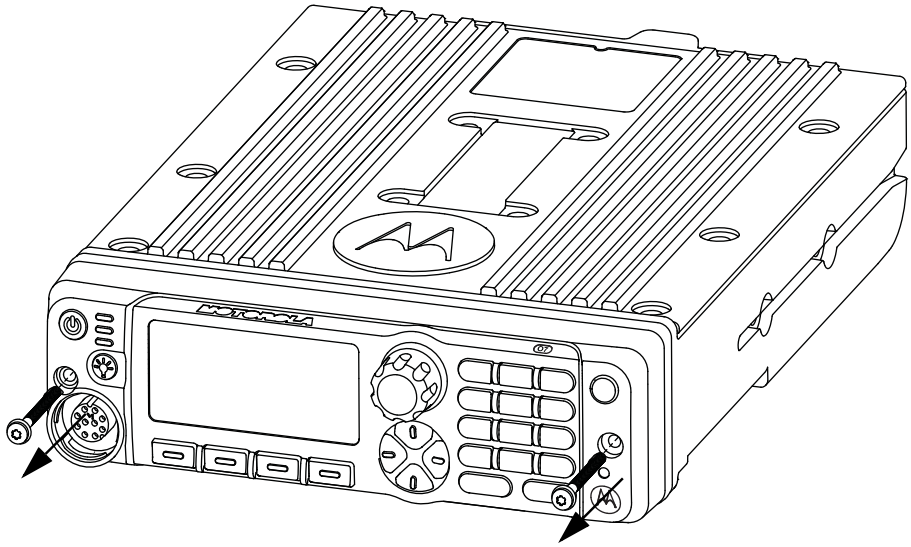
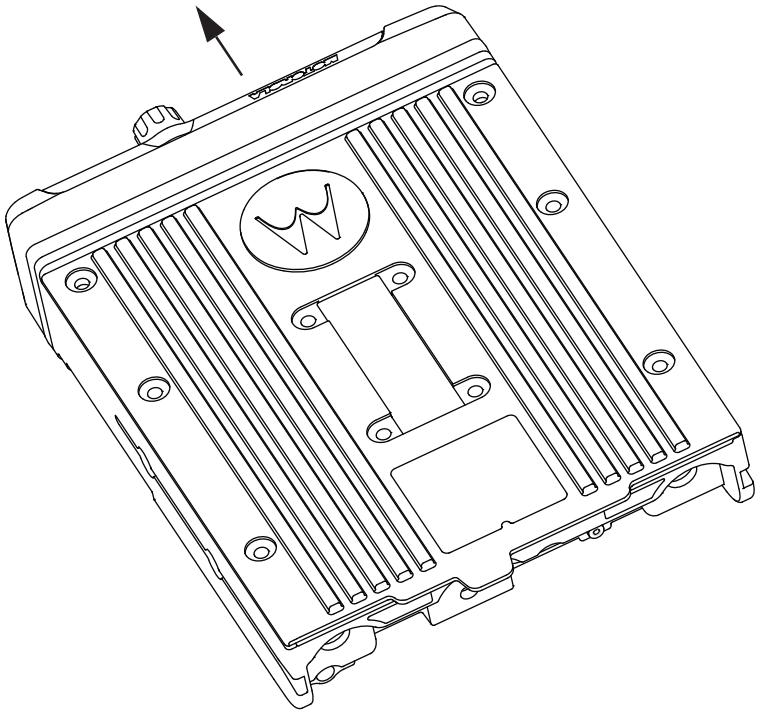
   
3. Firmly grasp the control head or the Transceiver Interface Board (TIB) for remote mount, and carefully remove the control head from the transceiver. Be careful not to pull on the attached flex.

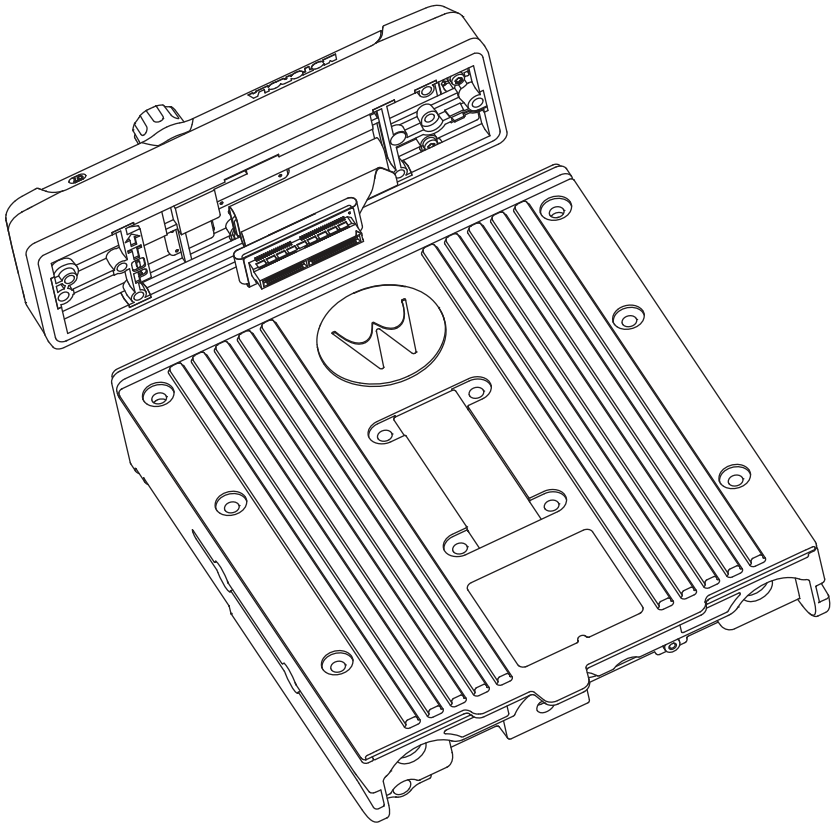
Figure 196: Removing the Control Head



4 Lay the control head or TIB face down on a clean flat surface, and be careful not to scratch or mar the surface of the display.

5 Carefully remove the transceiver flex from the transceiver by grasping the provided handle and separating it from the connector. Set the transceiver aside.

Figure 197: Disconnecting the Transceiver Flex from the Transceiver



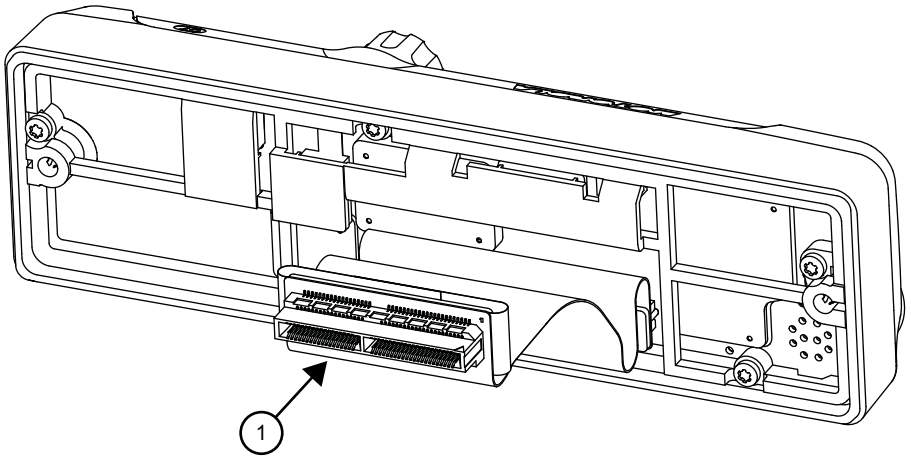
6 Carefully separate the I-seal from the control head or TIB.

NOTE: Be careful not to damage the transceiver flex when separating the I-seal from the control head or TIB.

7 Carefully disconnect the transceiver flex from the control head or TIB.

NOTE: The O2/O7 knob removal tool can be used as a lever to simplify the task of disconnecting the transceiver flex and reduce the risk of damaging the connectors.

Figure 198: Removing the Transceiver Flex



1	Transceiver Flex

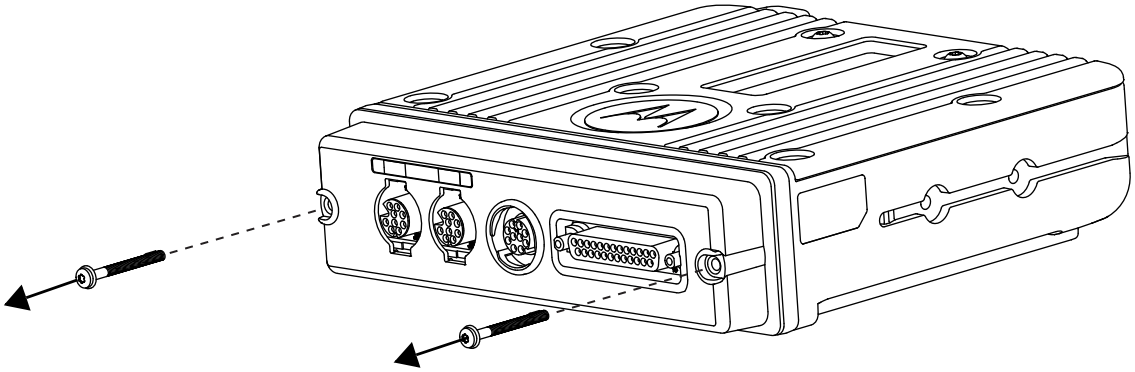
8.1.18.7

TIB Disassembly

Procedure:

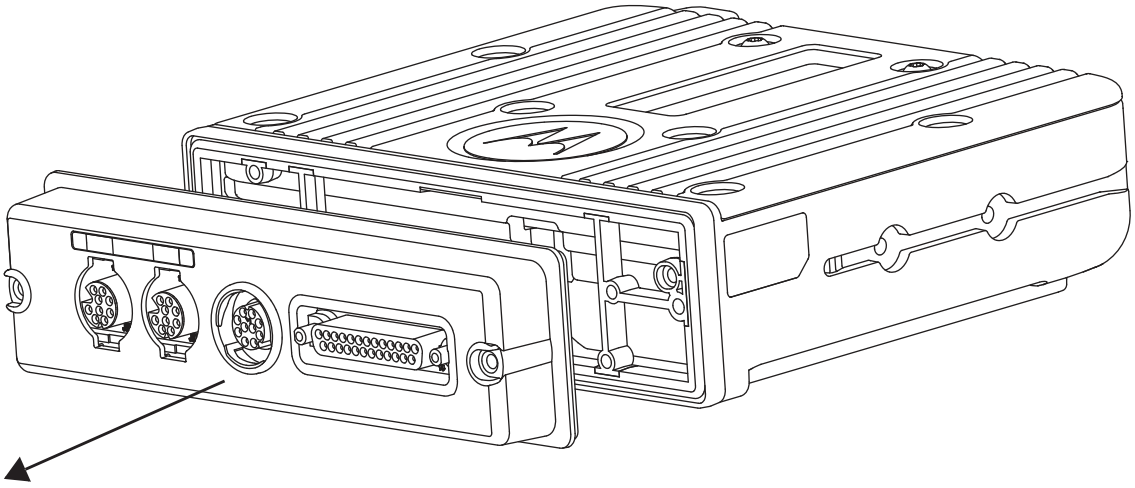
1. Ensure all accessories connections, power, antenna, and microphone are unplugged. If radio is in remote mount configuration, disconnect the remote-mount control cable (CAN cable) from the transceiver.
2. Remove the two (2) transceiver interface board (TIB) screws using a T-10 torx bit, do not discard screws.

   Figure 199: Removing the TIB Screws



3. Firmly grasp the TIB front housing and frame seal, and carefully remove from the radio. Be careful not to pull on the attached flex or damage the edge card during TIB removal.
4. Lay the TIB face down on a clean, flat surface, being careful not to scratch or mar the face of the display.

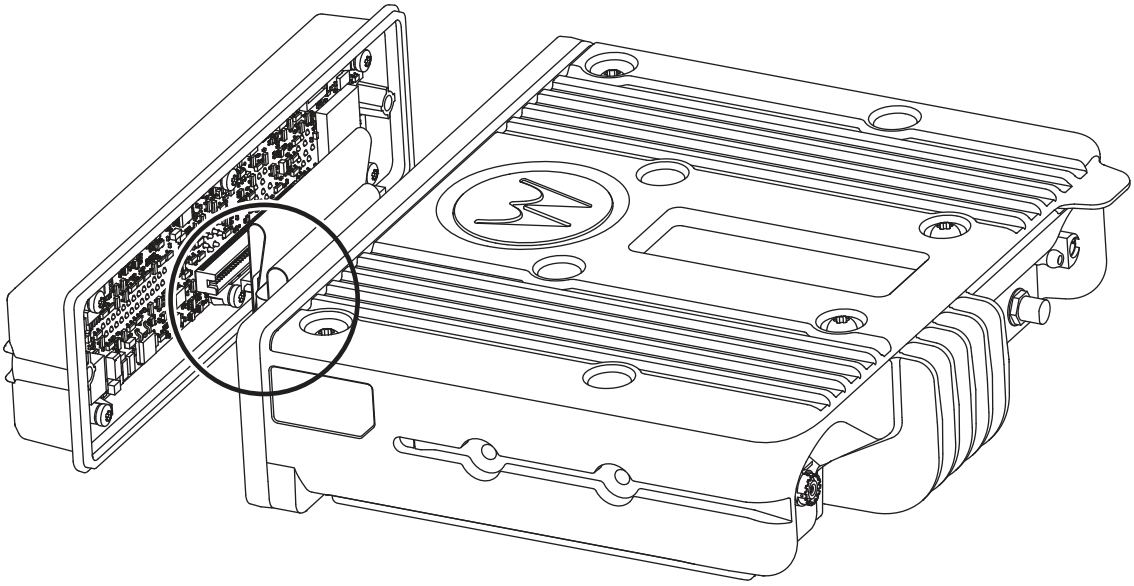
   Figure 200: Laying down the TIB



5 Carefully disconnect TIB flex/ remote mount flex from transceiver's edge card.

NOTE: "Carefully" means that the control head flex shall be disconnected from its mating control head connector by applying equal amounts of pressure on both ends of the mated pair until they fully disconnect. While disconnecting, make sure both mated pairs are pulled apart in a straight-forward [or "in-line"] direction parallel to the longitudinal axis of the connector pins.
.

Figure 201: Disconnecting Remote Mount Flex from the Transceiver

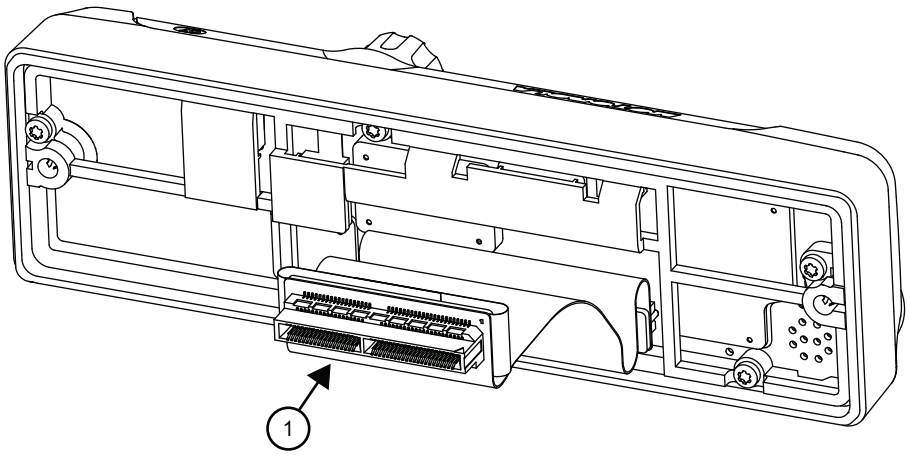


6 Carefully separate the I-seal from the TIB.

NOTE: Be careful not to damage the remote mount flex when separating the I-seal from the TIB.

7 Carefully disconnect the transceiver flex from the TIB.

Figure 202: Separating I-Seal from TIB



1	Transceiver Flex

8.1.19
Radio Reassembly

This section describes the reassembly of your radio.

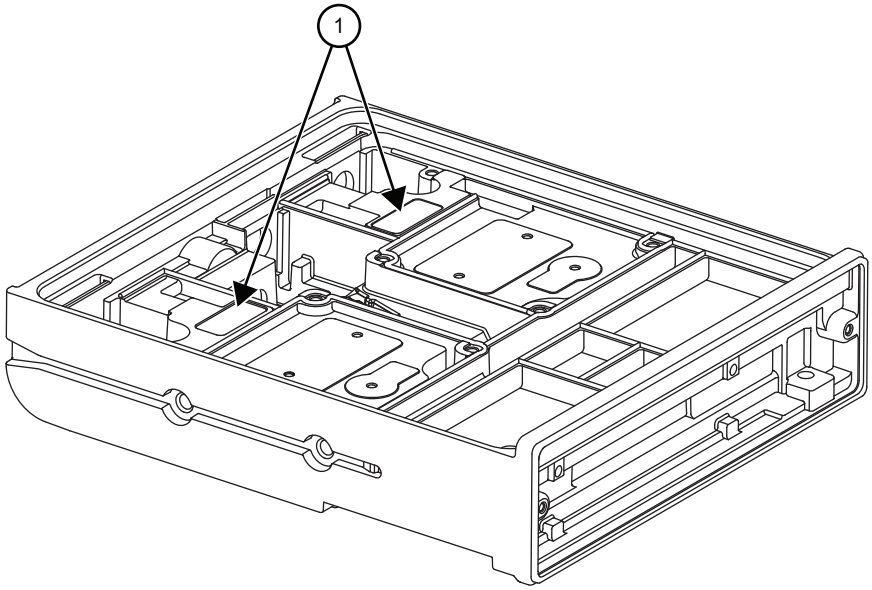
8.1.19.1
APX 5500/APX 6500/APX 7500/APX 6500Li Mid Power Models

NOTE: Prior to reassembling the radio, inspect all seals and sealing surfaces for damage (nicks, cuts, and so on) or dirt. Reseat all seals on their respective parts.

Procedure:

1 Begin with the chassis. Thoroughly inspect the chassis shield gasketing for damage and verify all chassis thermal pads are in place and free of damage. See Chassis Thermal Pad Replacement Procedure on page 293 to replace damaged pads.

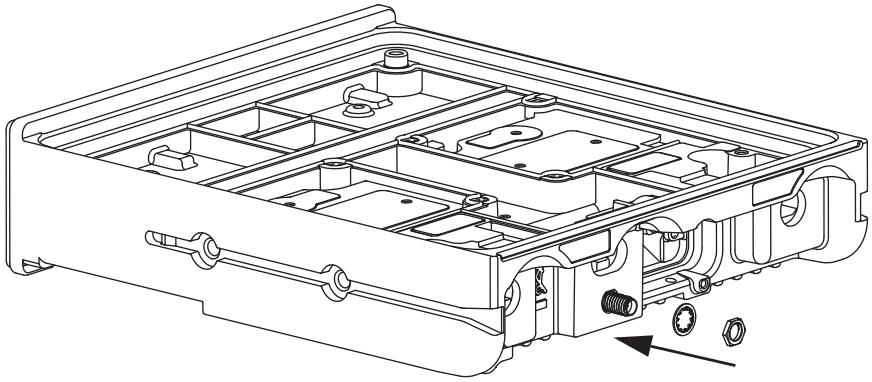
Figure 203: Inspecting the Chassis Shield Gasketing and Thermal Pads



1	Thermal Pad

2 After inspecting the GPS cable and seating the seal on the SMA connector ferrule, insert the GPS SMA connector through the GPS cable chassis opening, ensuring the notch on the GPS connector is down and aligned with the protrusion on the chassis. Install the lock washer. Install the GPS nut using a 5/16” nutdriver and torque nut to 7-9 in-lbf.

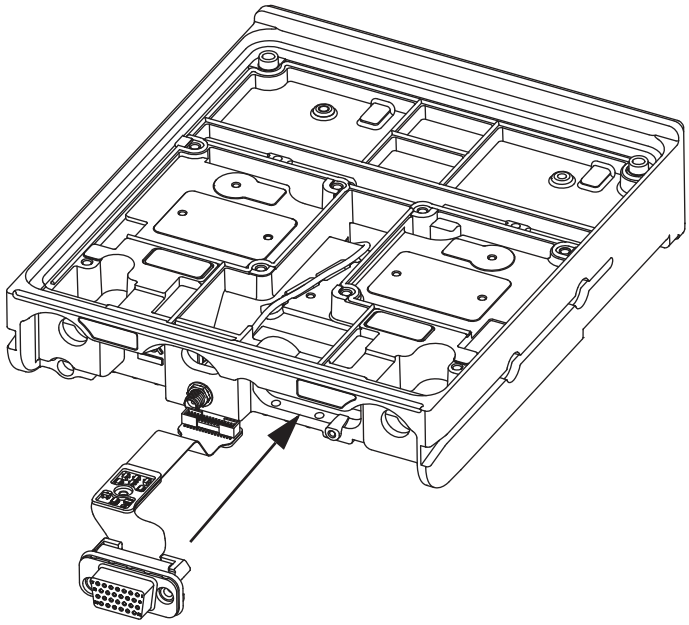
Figure 204: Installing the GPS Nut and Torque Nut



3 Insert free end of GPS cable through the RF/controller board chassis opening. Retain cable by pushing cable into chassis pinch points.

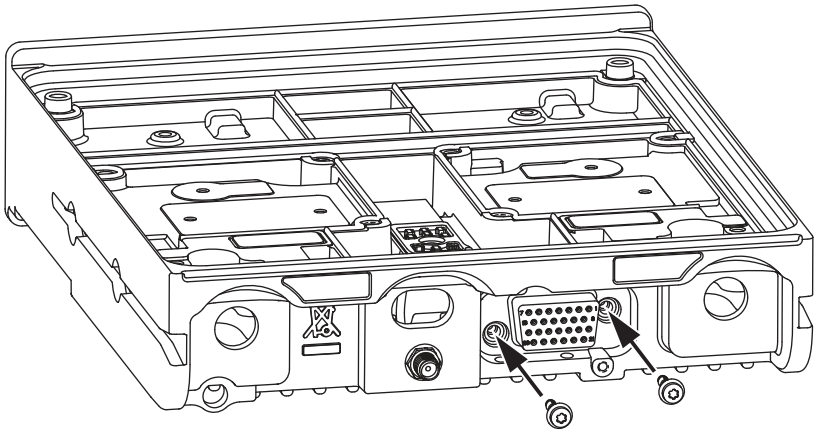
4 Insert rear accessory flex through rear chassis opening. Be sure flex is oriented with components facing up. Insert free end of accessory flex through the RF/controller board chassis opening.

Figure 205: Inserting Rear Accessory Flex



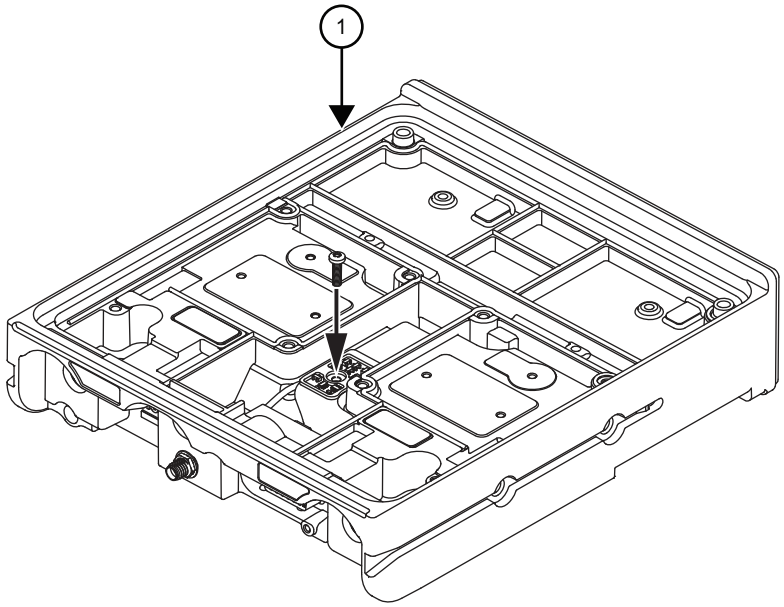
5 Install the two (2) rear accessory connector screws using a T-10 Torx bit. Be sure the rear accessory screws each have one (1) washer and one (1) seal. Torque rear accessory connector screws to 6-8 in-lbf.

Figure 206: Installing Rear Accessory Connector Screws



6 Ensure flex is positioned as shown in the following figure with small connector end of the flex passed through the RF/controller board chassis opening. Install accessory flex screw using a T10 Torx bit. Torque accessory flex screw to 6-8 in-lbf.

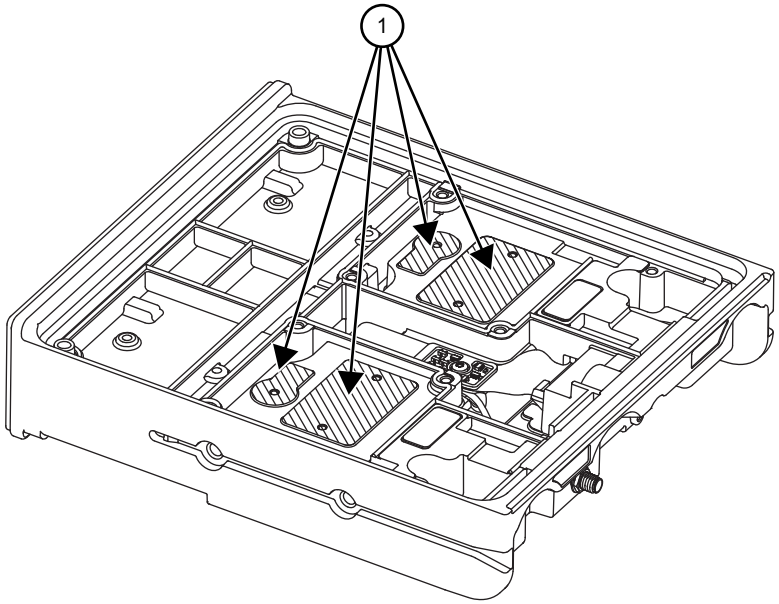
Figure 207: Installing Accessory Flex Screw



1	RF/controller board chassis opening

7 Reapply thermal grease (1110022D23) to all RF board heat sinks. All heat sinks need to be covered with a smooth thin layer of thermal grease.

Figure 208: Applying Thermal Grease to RF Board Heat Sinks

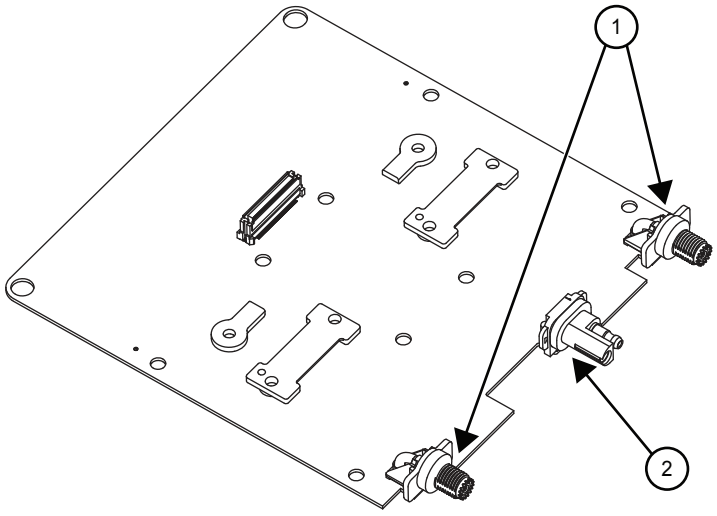


1	Thermal Grease

8 Check that the DC connector seal on the RF board is properly seated.

9 Check that the RF connector seals on the RF board are properly seated.

Figure 209: Ensuring RF and DC Connector Seals are properly seated



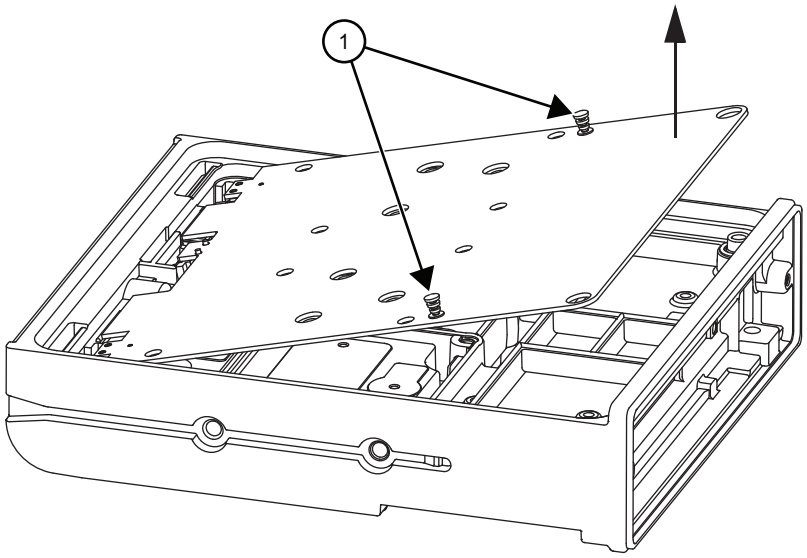
1	RF Connector Seals
2	DC Connector Seal

10 Install RF board by tilting and sliding into chassis using the two (2) RF board handles, taking care to line up the two (2) RF and one (1) DC connectors through the rear holes of the chassis. To fully seat RF board, push back and down on the board using the two (2) RF board handles

to slightly compress RF/DC seals. Ensure that the RF board alignment holes are positioned over the chassis alignment bosses and that the RF board is fully seated in chassis.

NOTE: It is important that the RF Boards get assembled before the placement of the Controller board and the assembly of the Controller Cover.

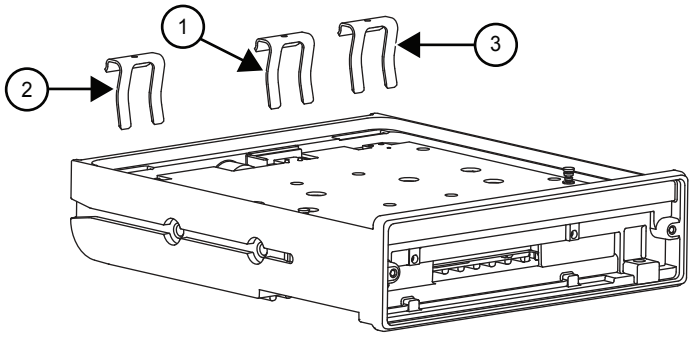
Figure 210: Inserting RF Board into Chassis



1	Board Handles

11 Insert the RF/DC retention clips and fully seat them. The DC clip should be placed first then the RF clips. All clips must be inserted before the board screws to properly locate RF board.

Figure 211: Inserting RF/DC Retention Clips

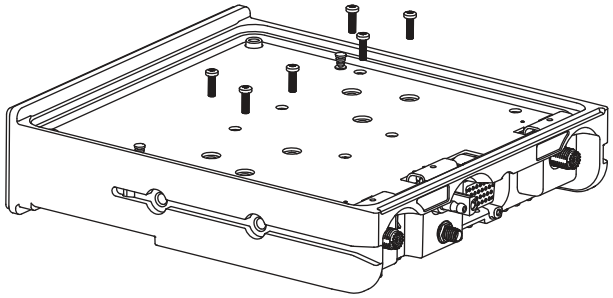


12 Install the PA screw using a T-10 Torx bit. Three PA screws are needed for single band radios, six (6) PA screws are needed for dual band radios. Torque down the PA screws to 12–14in-lbs.

Table 64: Number of PA Screws to Install

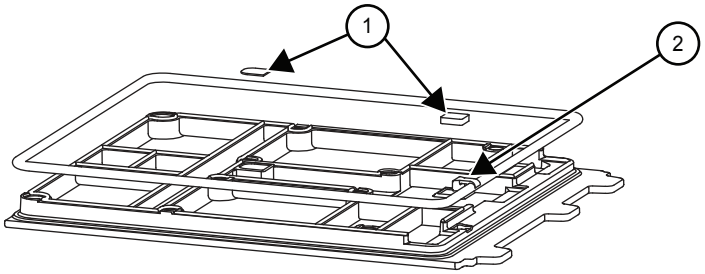
Radio Bands	PA Screws
Single Band	3
Dual Band	6

Figure 212: Installing PA Screws



13 Inspect RF cover for installation of the reverse polarity and voltage regulator thermal pads. Then inspect and properly seat the RF cover seal. Be careful to properly align the RF cover seal tab to the RF cover.

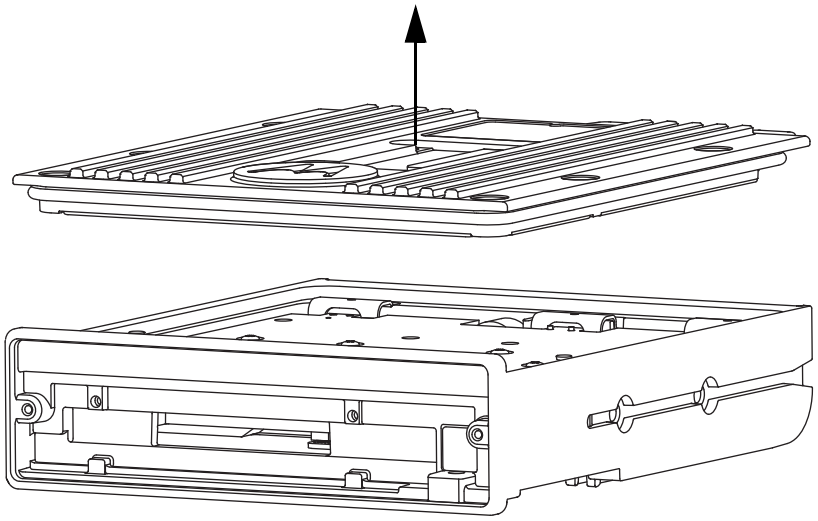
Figure 213: Inspecting Thermal Pad and Installing RF Cover Main Seal



1	Thermal Pads
2	RF Cover Seal Tab

14 Place the RF cover onto the chassis. Be sure RF cover is properly aligned to chassis. The RF cover and chassis can be compressed together to squeeze seal into place.

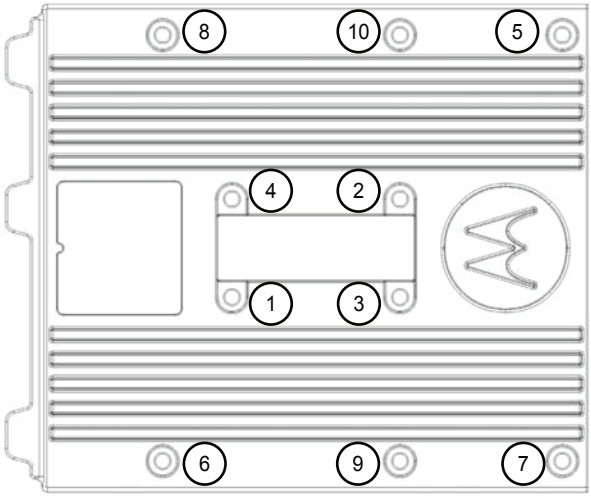
Figure 214: Securing RF Cover to Chassis



15 Inspect the sealing washers to the ten (10) RF cover screws, and then install the screws onto the RF cover/chassis. Torque the RF cover screws to (34-36 in-lbf), be sure to torque screws using the indicated order to ensure RF cover is properly seated.

NOTE: Repeat torque order sequence at least twice.

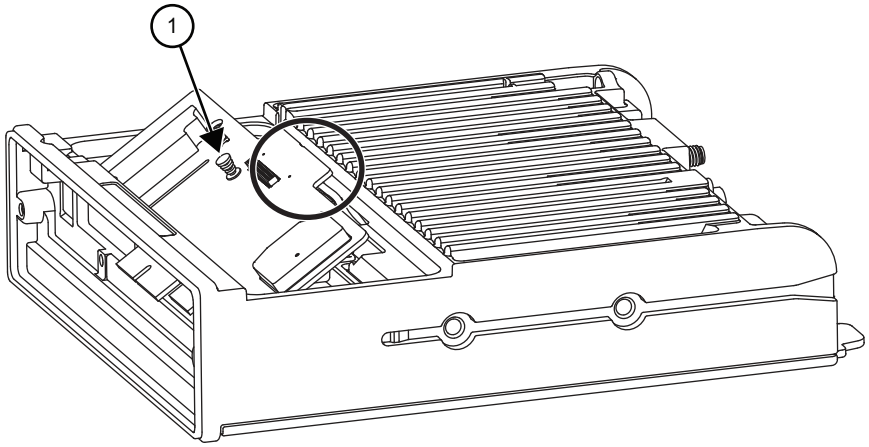
Figure 215: Securing the RF Cover to the Chassis



16 Once RF cover is fully installed, check the RF cover-chassis interface to ensure the RF cover seal is not pinched.

17 FLIP RADIO OVER: Install the controller board into the chassis by tilting controller board edge card through front opening using the controller board handle and then down into the chassis. Be sure to hold GPS cable and accessory flex out of controller chassis pocket. Once controller board is placed in chassis, use the controller board handle to align controller board-to-board (BTB) connector to the RF BTB connector. Once aligned press down on controller board, as shown in the circled area below, to connect the controller/RF BTB connectors.

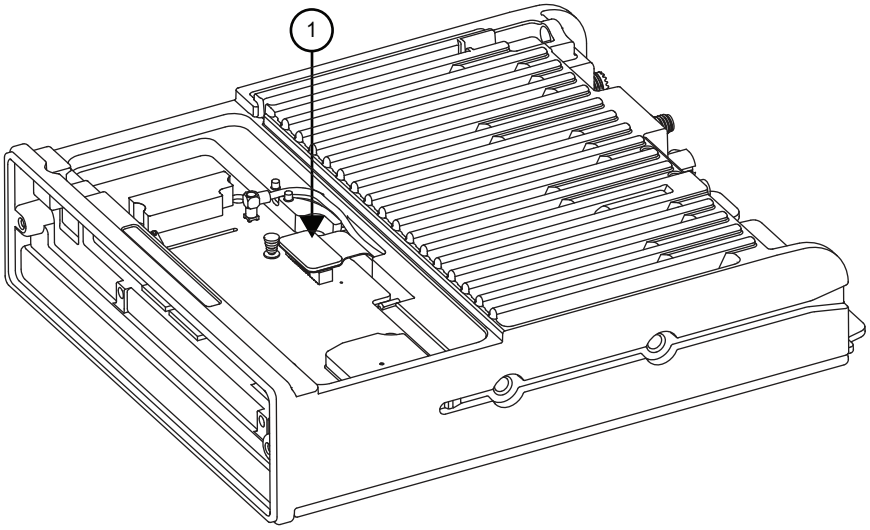
Figure 216: Installing the Controller Board into the Chassis



1	Controller Board Handle

18 Install the accessory flex connector to the controller board connector. Press down on flex backer to ensure proper connection.

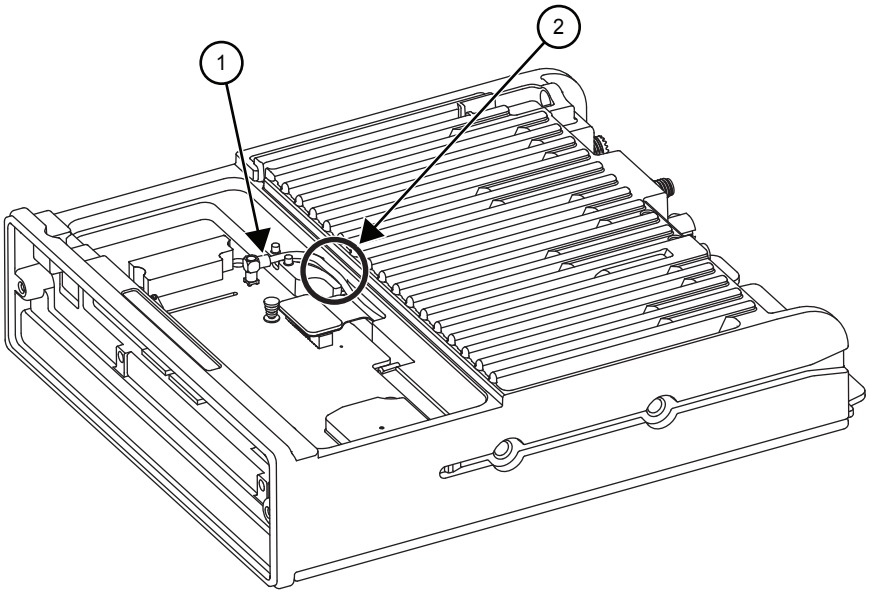
Figure 217: Installing the GPS Connector to the Controller Board



1	Pressing down on flex backer

19 Install the GPS MMCX connector to the controller board. Be sure that GPS cable is aligned in the GPS cable retention channel. Firmly press down on GPS MMCX connector to snap connector into place. Press cable down into chassis pinch point. Do not press or pull cable as damage may occur.

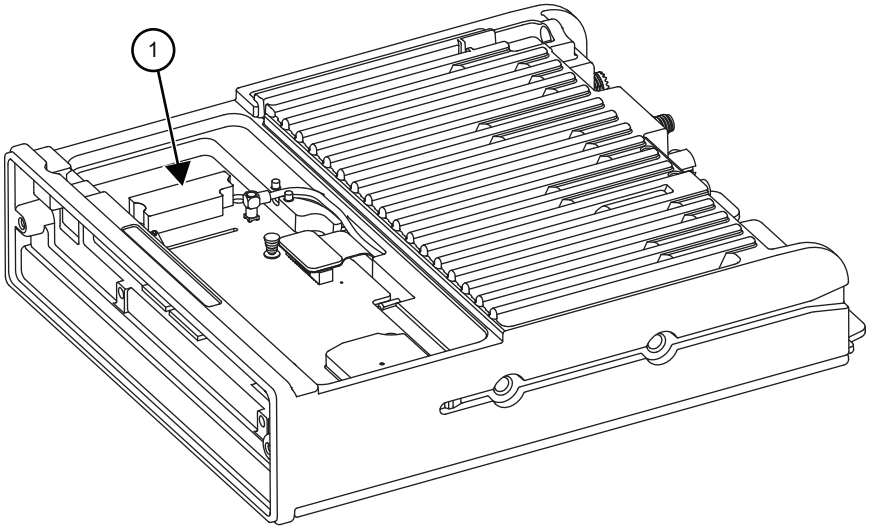
Figure 218: Install the Accessory Flex Connector to the Controller Board



1	GPS MMCX Connector
2	Pinch Point

20 Reapply thermal grease (p/n 1110022D23) to the controller board heat sink. The heat sink needs to be covered with a smooth, thin layer of thermal grease.

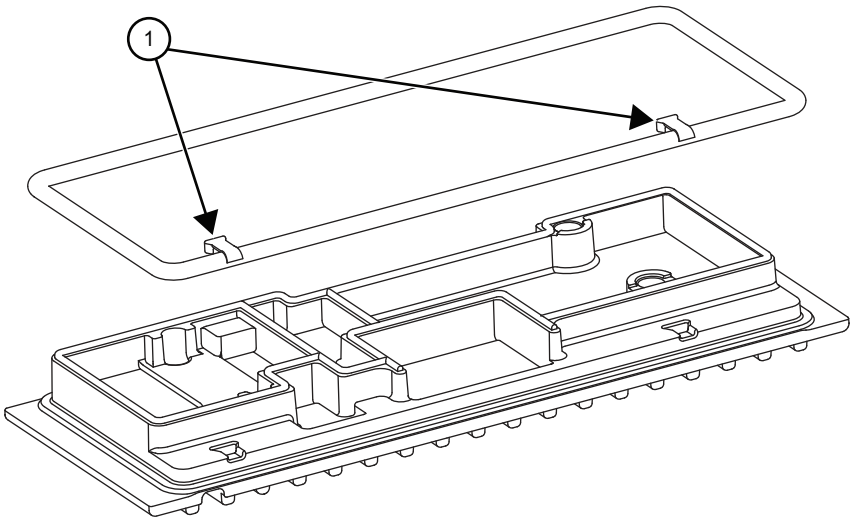
Figure 219: Applying Thermal Grease to the Controller Cover



1	Thermal Grease Area

21 Inspect and install controller cover seal onto the controller cover. Be sure to correctly align the two (2) controller cover seal tabs to the controller cover.

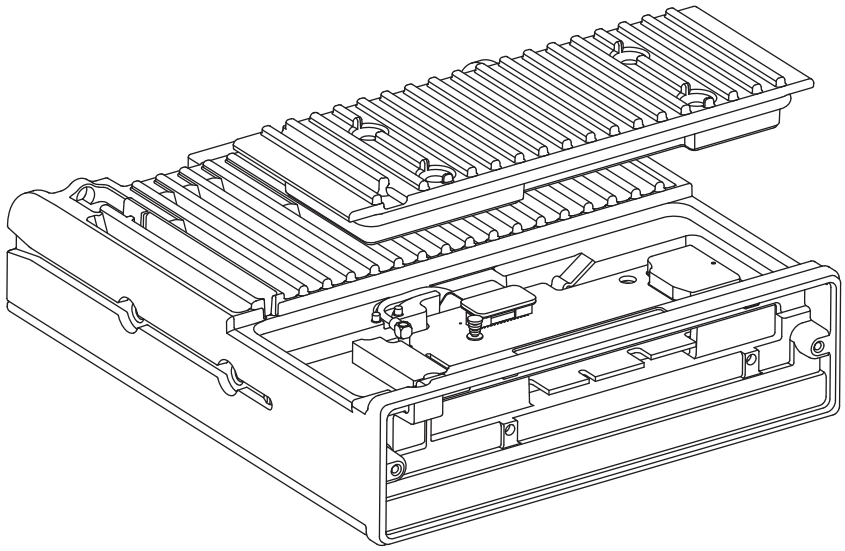
Figure 220: Inspecting and installing Controller Cover Seal onto Controller Cover



1	Controller Cover Seal Tabs

22 Place the controller cover onto the chassis. Be sure that controller cover is properly aligned to chassis. The controller cover and chassis can be compressed together to squeeze seal into place.

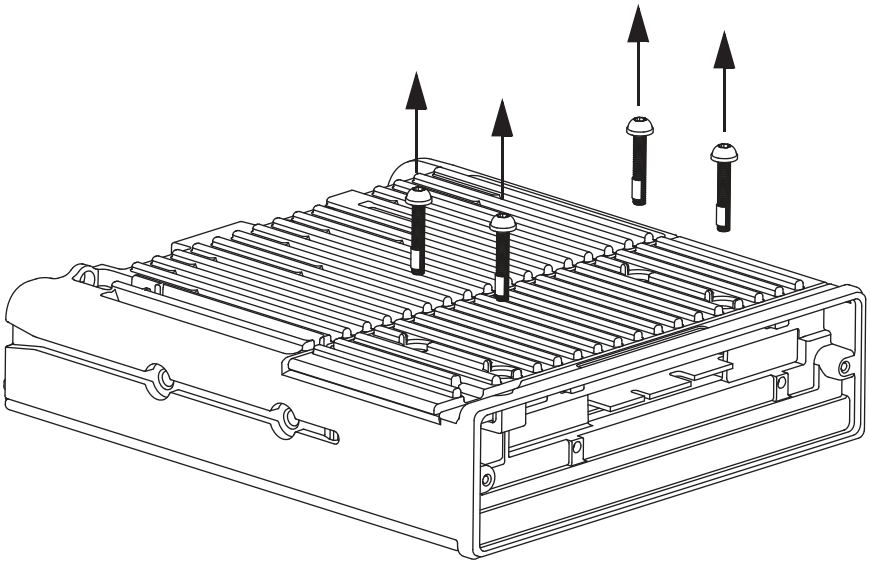
Figure 221: Placing Controller Cover onto Chassis



23 Inspect the sealing washers to the four (4) controller cover screws, and then install the screws onto the controller cover. Torque the controller cover screws to (34-36 in-lbf), be sure to torque screws starting with the bottom left screw and going around clockwise (see Figure 222: Securing the Controller Cover Screws on page 259) to ensure that controller cover is properly seated.

NOTE: Repeat torque order sequence at least twice.

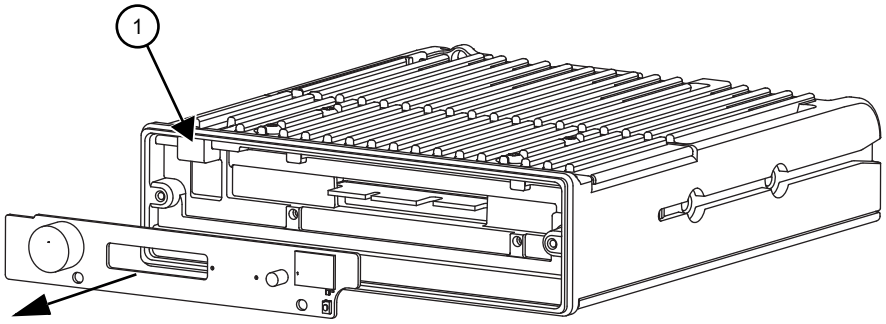
Figure 222: Securing the Controller Cover Screws



24 Once controller cover is fully installed check controller cover-chassis interface to ensure that there is not a pinched controller cover seal. For Radios not equipped with an Option Board, skip to step 27.

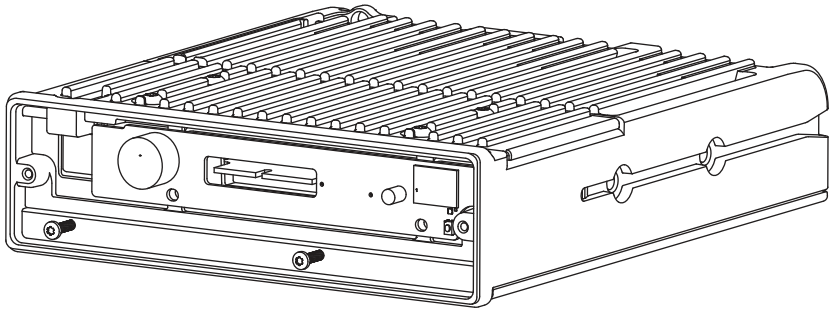
25 Install the option board onto the front of the chassis by using the option board handle and plugging the option board edge card connector in to the shorter, single exposed edge card.

Figure 223: Installing the Option Board



1	Option Board Edge Card

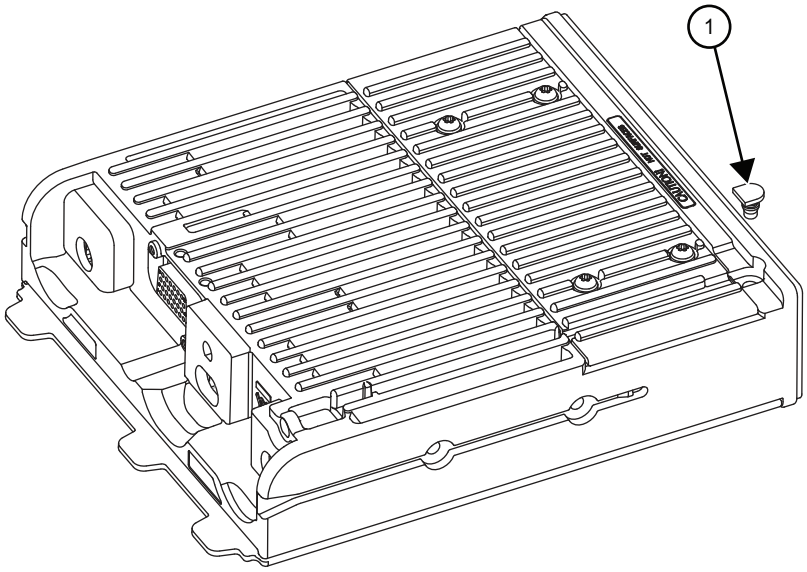
Figure 224: Installing the Option Board Screws



26 Install the two (2) option board screws using a T-10 torx bit. Torque the option board screws to 6-8 in-lbf.

27 If WLAN Port Plug removed: To re-assemble, align plug to chassis opening and press down to seat. To aid in seating the plug it can be pulled from inside chassis with either tweezers or small needle nose pliers taking care not to damage the sealing surface.

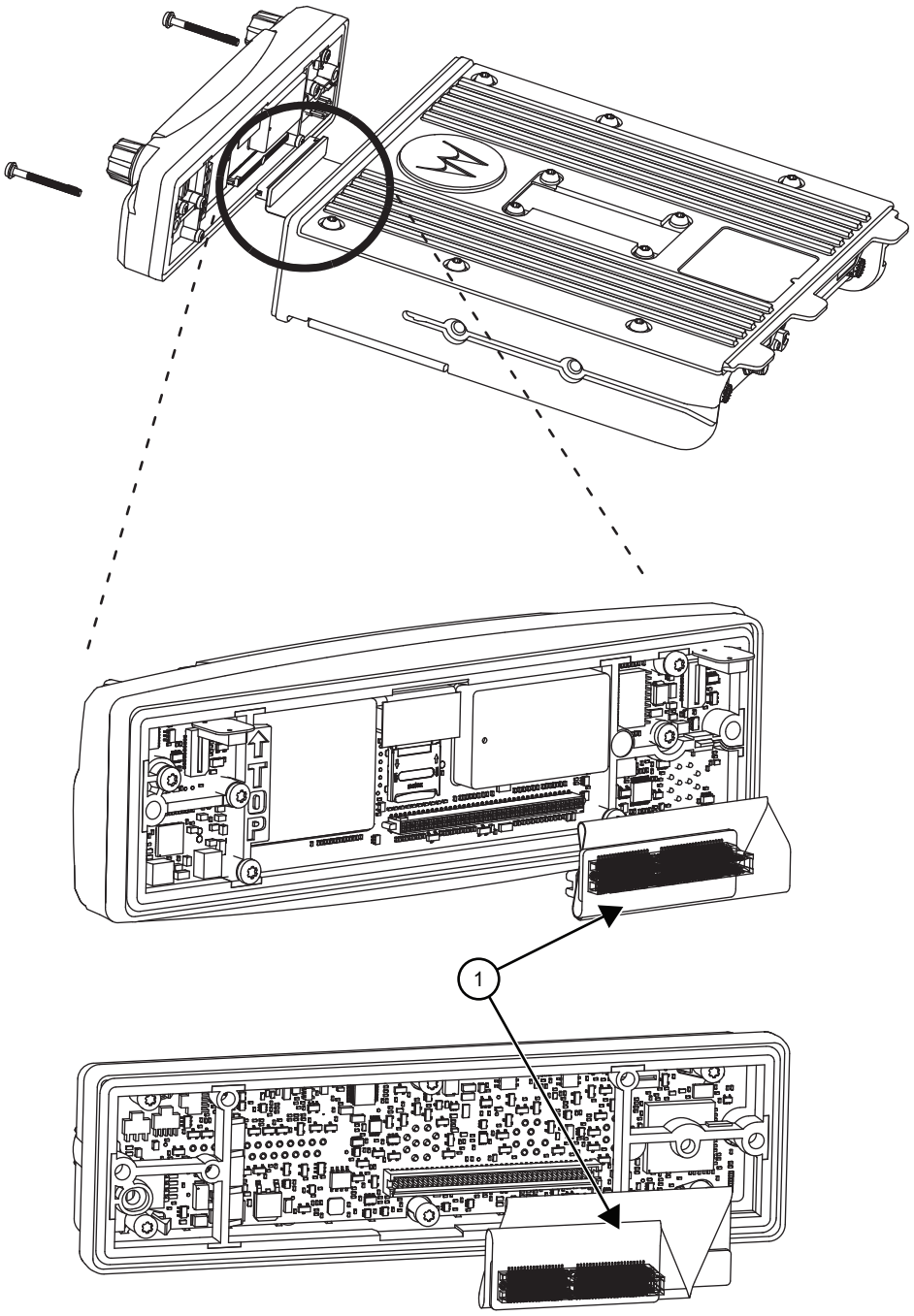
Figure 225: Installing the WLAN Port Plug



1	WLAN Port Plug

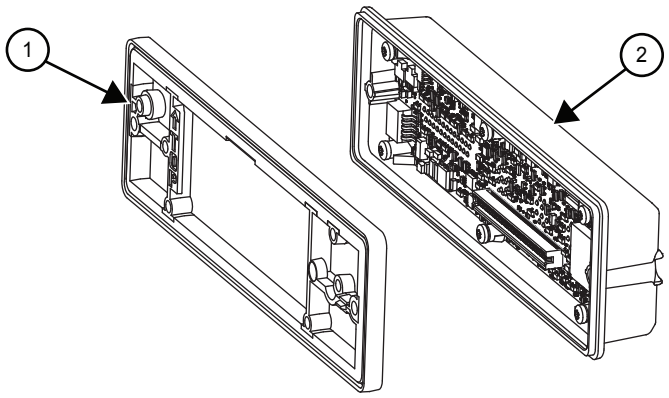
28 Attach the control head/TIB flex edge card connector to edge card. Be sure to properly align edge card connector to exposed edge card.

Figure 226: Installing Flex into Controller PCB



29 TIB: Align the frame seal to TIB. Compress TIB and frame seal together to be fully seated.

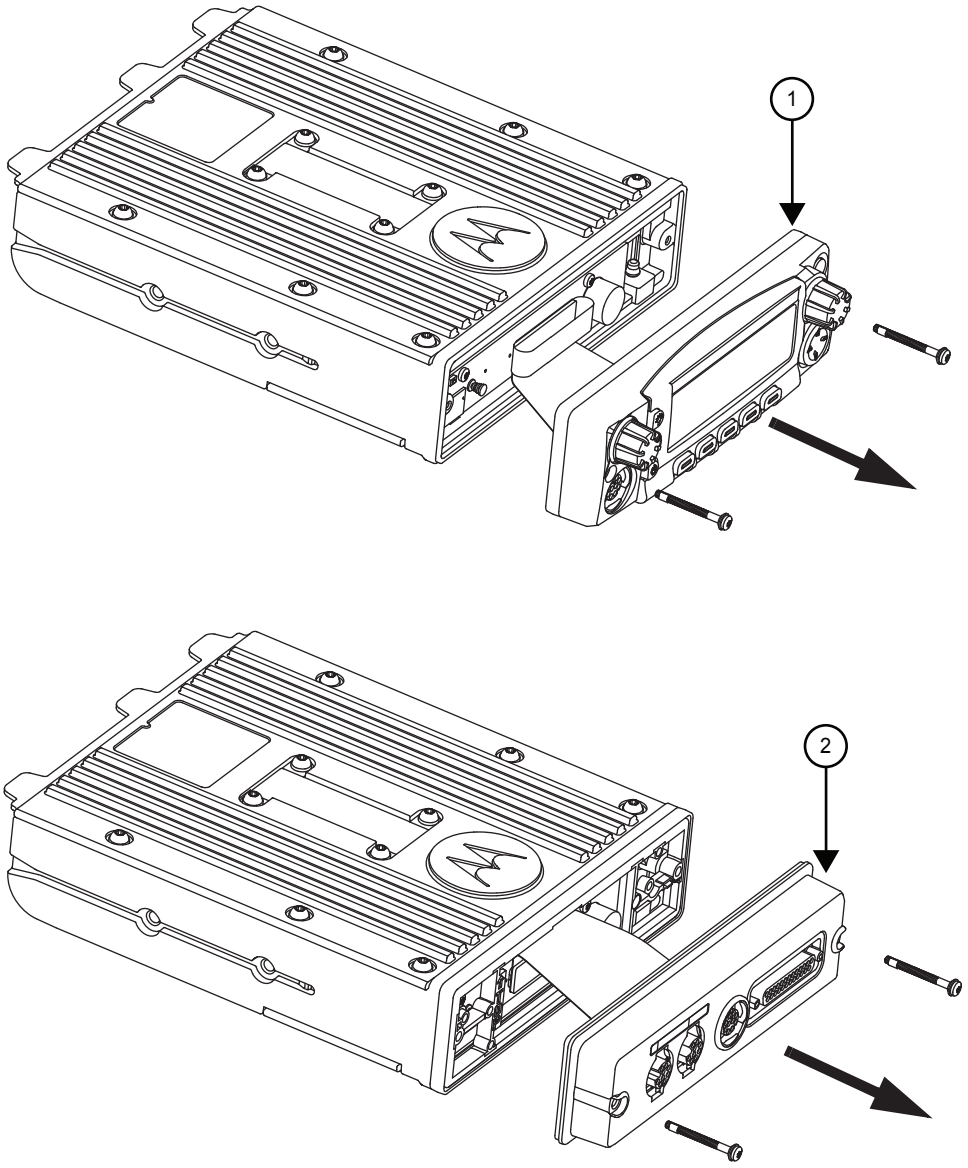
Figure 227: Aligning frame seal to TIB



1	Frame Seal
2	TIB

30 Install control head/TIB flex to control head/TIB. Be sure to properly align connectors before connecting.

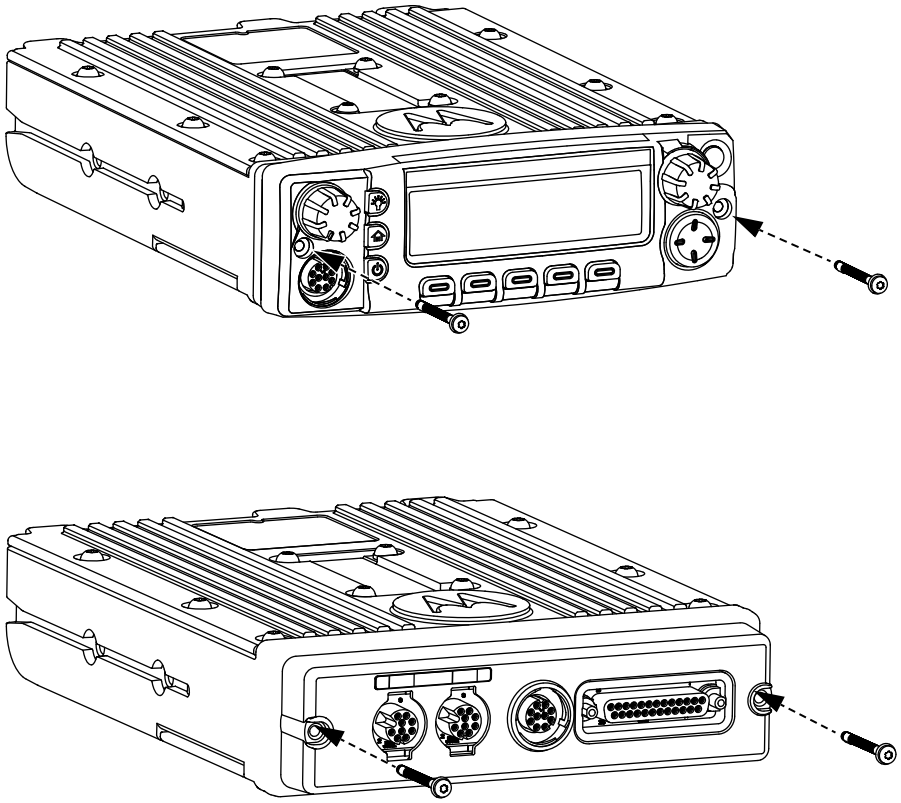
Figure 228: Installing Control Head/TIB Flex to Control Head/TIB



1	Control Head
2	TIB

31 Align control head/TIB to front of chassis using the frame seal. Install two (2) control head/TIB screws. Be sure the control head/TIB screws each have one (1) washer and one (1) seal installed. Torque down control head/TIB screws to 8-10 in-lbf.

Figure 229: Aligning Control Head/TIB front of chassis, and Installing the Control Head/TIB screws



8.1.19.2

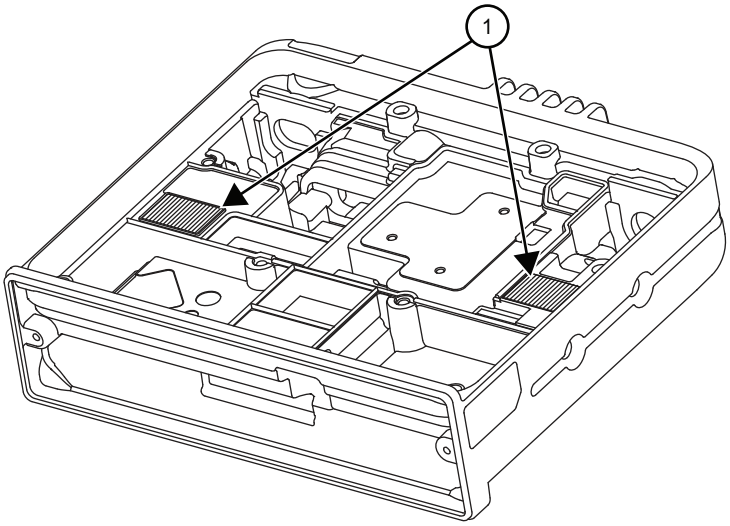
Mid Power Models

Prerequisites: Prior to reassembling the radio, inspect all seals and sealing surfaces for damage (nicks, cuts, and so on) or dirt. Reseat all seals on their respective parts.

Procedure:

1 Begin with the chassis. Thoroughly inspect the chassis shield gasketing to ensure that there is no damage, and verify all chassis thermal pads are in place and free of damage. See Chassis Thermal Pad Replacement Procedure on page 293 to replace damaged pads.

Figure 230: Inspecting the Chassis Shield Gasketing and Thermal Pads

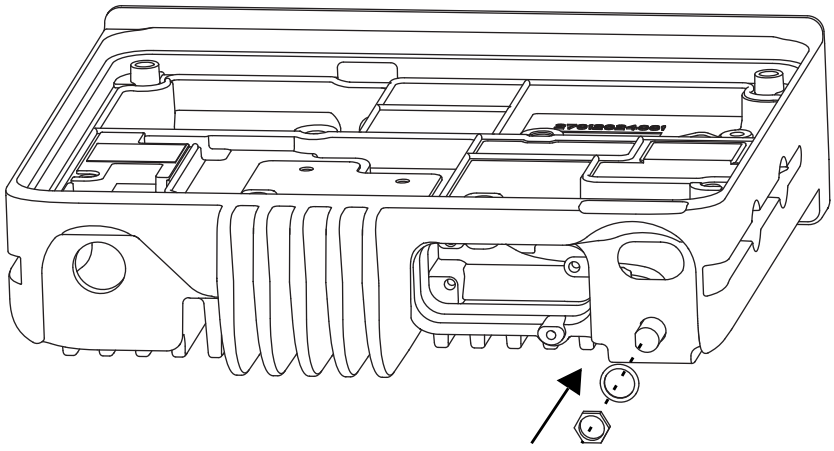


No.	Description
1	Thermal Pad

2 After inspecting the GPS cable and placing seal on the SMA connector ferrule, insert the GPS SMA connector through the GPS cable chassis opening, while ensuring the notch on the GPS connector is down and aligned with the protrusion chassis. Install the lock washer. Install the GPS nut using a 5/16” nutdriver and torque nut to 15 lbf-in.

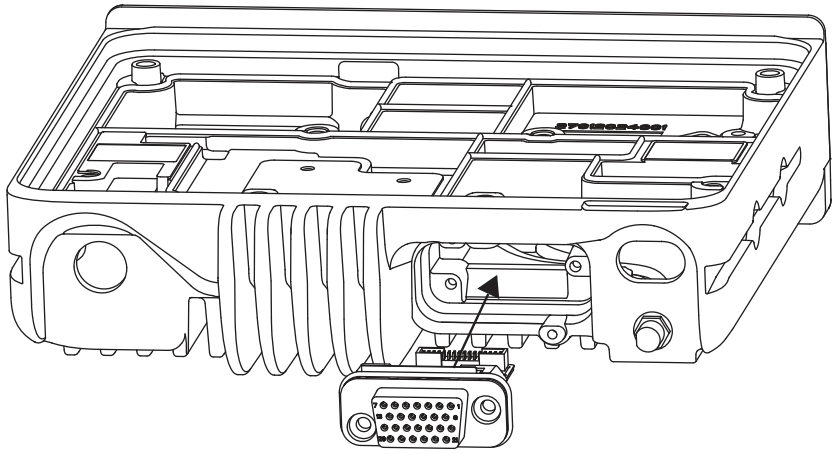
3 Insert the free end of the GPS cable through the RF/controller board chassis opening. Retain the cable by pushing it into chassis pinch points.

Figure 231: Inserting GPS cable



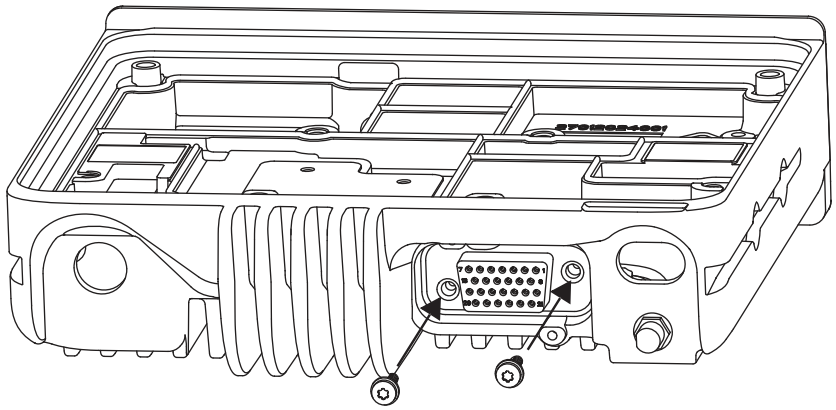
4 Insert the rear accessory flex through the rear chassis opening. Ensure that the flex is oriented with the facing up components. Insert the free end of the accessory flex through the RF/controller board chassis opening.

Figure 232: Inserting Rear Accessory Flex



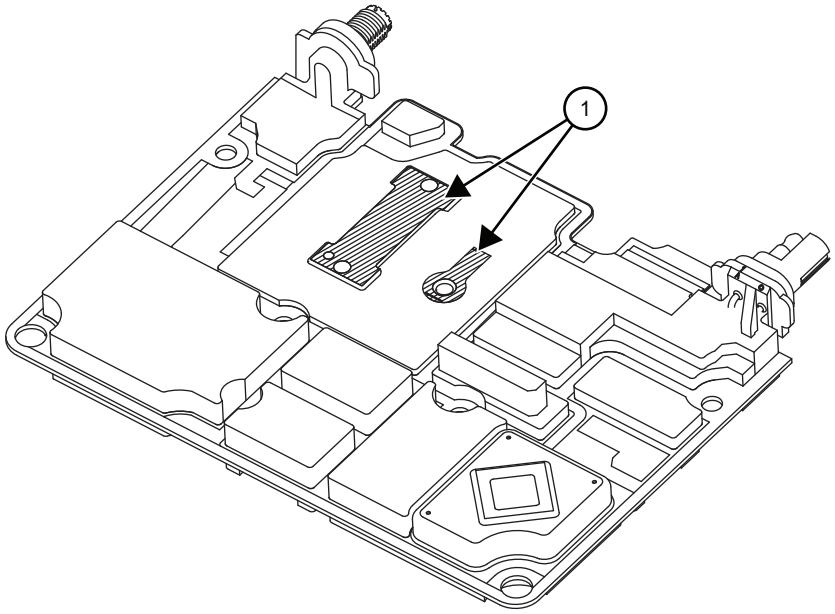
5 Install two (2) rear accessory connector screws using a T-10 Torx bit. Ensure that each rear accessory screw has one (1) washer and one (1) seal. Torque the rear accessory connector screws to 6-8 lbf-in.

Figure 233: Installing the Rear Accessory Connector Screws



6 Reapply thermal grease (1110022D23) to all RF board heat sinks. Cover all heat sinks with a smooth thin layer of thermal grease.

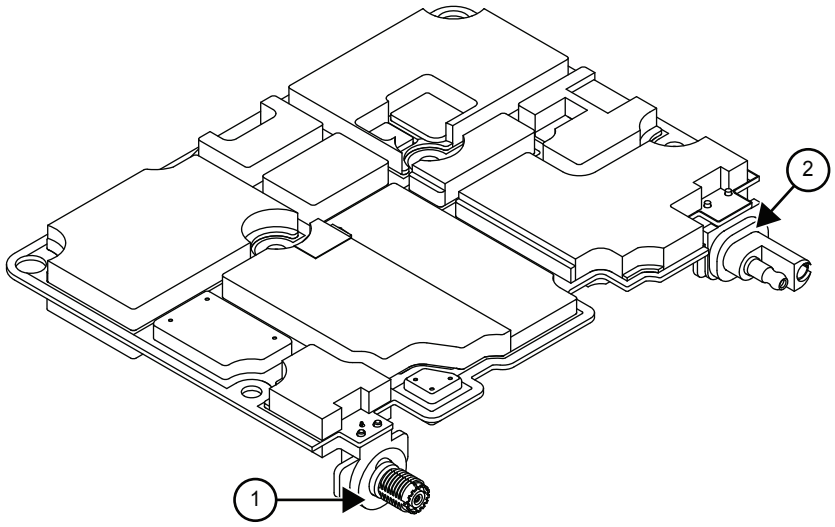
Figure 234: Applying the Thermal Grease to RF Board Heat Sinks



No.	Description
1	Thermal Grease

7 Ensure that the DC and RF connector seals on the RF board are properly seated.

Figure 235: Ensuring that the RF and DC Connector Seals are Properly Seated



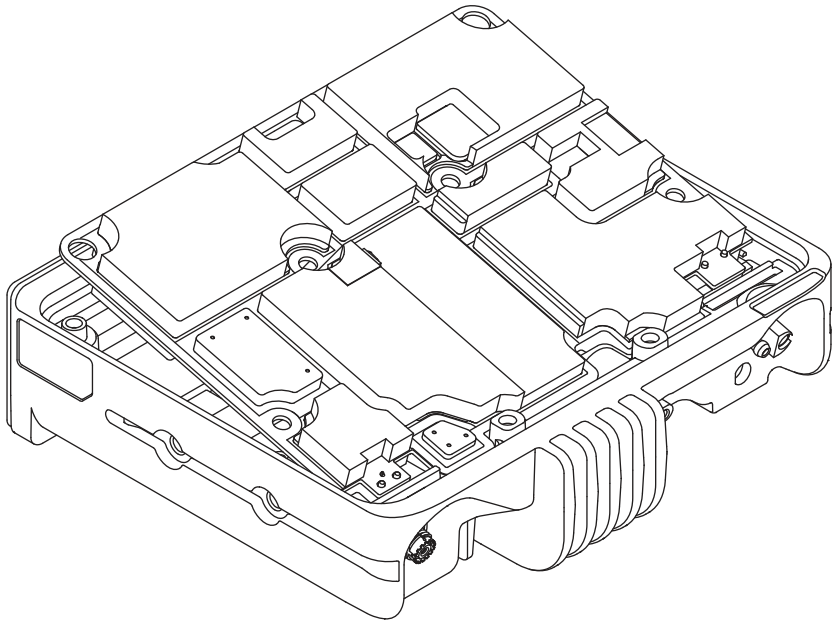
1	RF Connector Seal
2	DC Connector Seal

8 Install the RF board by tilting and sliding it into the chassis, and secure RF and DC connectors through the rear holes of the chassis. Push the RF board back and down to compress the RF and DC seals slightly, and ensure that it is properly seated. Ensure that the RF board alignment

holes are positioned over the chassis alignment bosses, and the RF board is fully seated in the chassis.

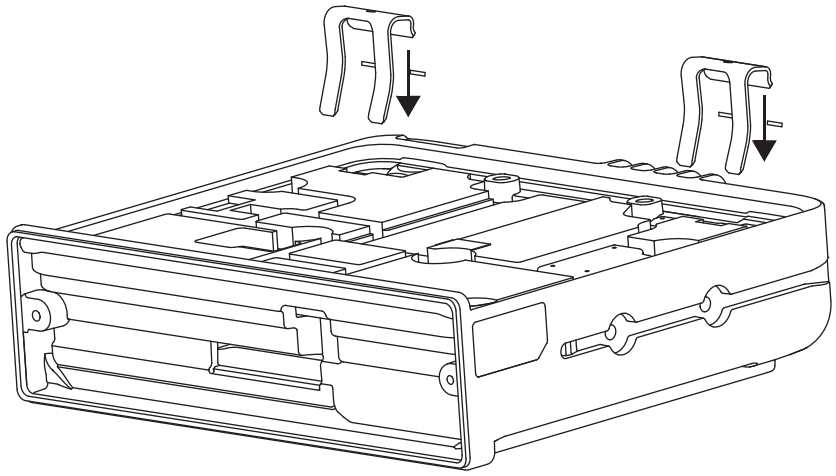
NOTE: It is important to assemble the RF Board, before placing the controller board and assembling the bottom cover.

Figure 236: Inserting RF Board into the Chassis



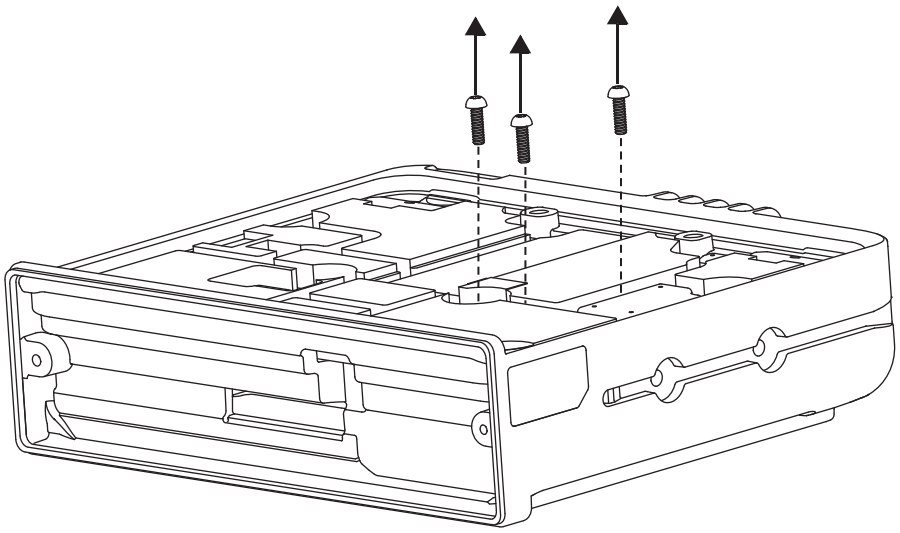
9 Insert the RF and DC retention clips, and ensure that they are fully seated. Insert all clips before board screws, to position the RF board properly.

Figure 237: Inserting the RF and DC Retention Clips



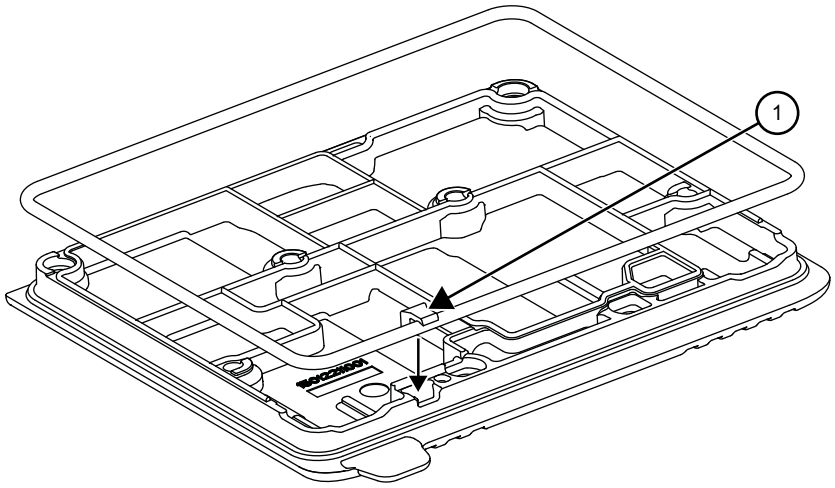
10 Install three (3) PA screws following the numbered sequence as shown in the following figure, using a T-10 Torx bit. Torque down the PA screws to 6-8 lbf-in.

Figure 238: Installing the PA Screws



11 Inspect and properly seat the top cover seal, and decently align its tab to the top cover.

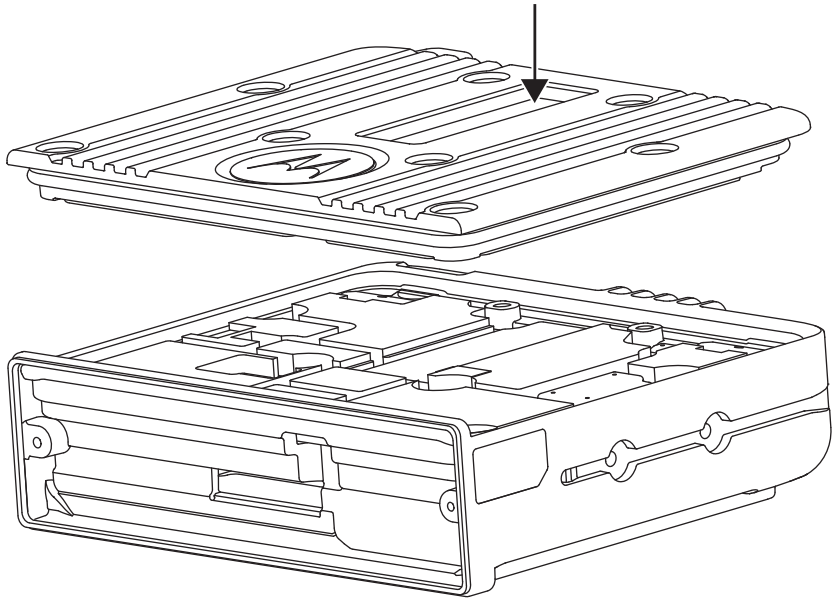
Figure 239: Inspecting and Installing the RF Cover Seal



No.	Description
1	RF Cover Seal Tab

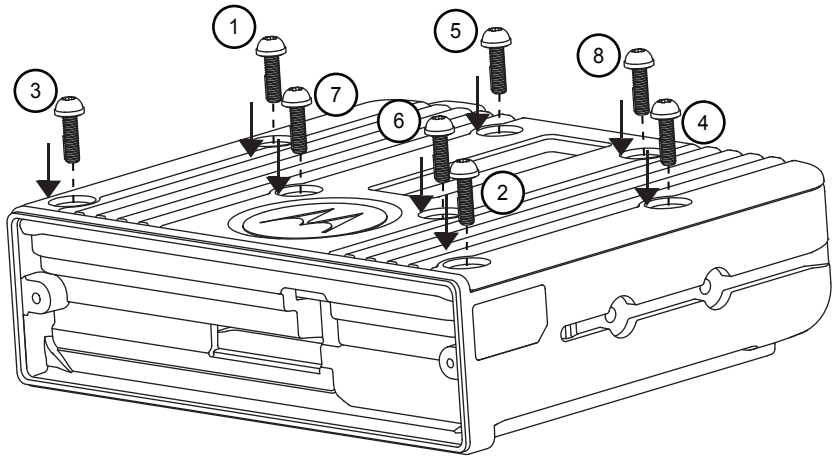
12 Place the top cover onto the chassis, and ensure that the top cover is properly aligned to the chassis. The top cover and chassis can be compressed together to squeeze seal into place.

Figure 240: Placing the RF Cover onto Chassis



13 Inspect the sealing washers on the eight (8) top cover screws, and install the screws onto the top cover/chassis. Torque the top cover screws to 30 lbf-in, following the numbered sequence shown in the following figure, to ensure that top cover is seated properly. Repeat the torque order sequence at least twice.

Figure 241: Installing Screws onto the RF Cover/Chassis



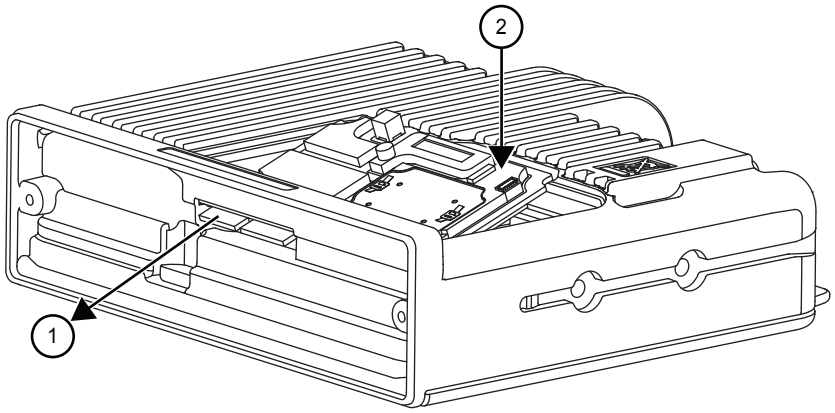
14 Once the top cover is fully installed, check the interface between the top cover and the chassis to ensure that the top cover seal is not pinched.

15 Flip the radio over.

a Install the controller board into the chassis by tilting the controller board edge card through the front opening using the controller board handle, and down into chassis. Ensure to hold the GPS cable and accessory flex out from the controller chassis pocket. Once the controller board is placed in the chassis, use the controller board handle to align the controller board-to-board (BTB) connector to the RF BTB connector.

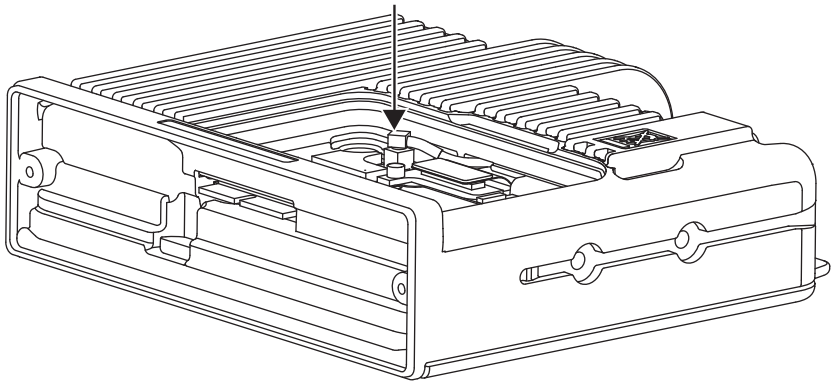
b Once aligned, press down the controller board as shown in the below numbers, to connect the controller/RF BTB connectors.

Figure 242: Installing Controller Board into Chassis



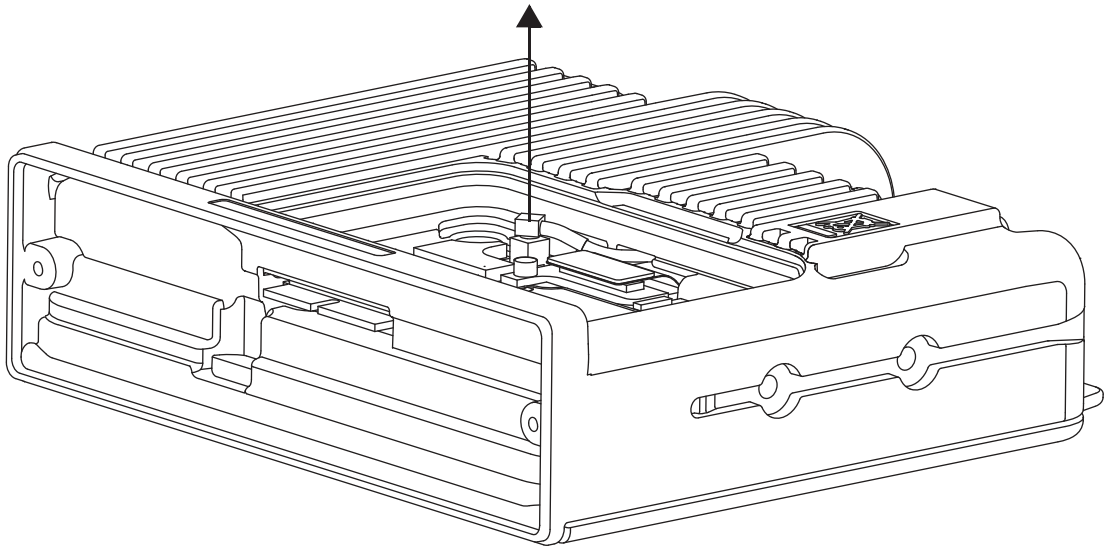
16 Install the accessory flex connector onto the controller board connector. Press down the flex backer to ensure proper connection.

Figure 243: Installing Accessory Flex Connector to the Controller Board



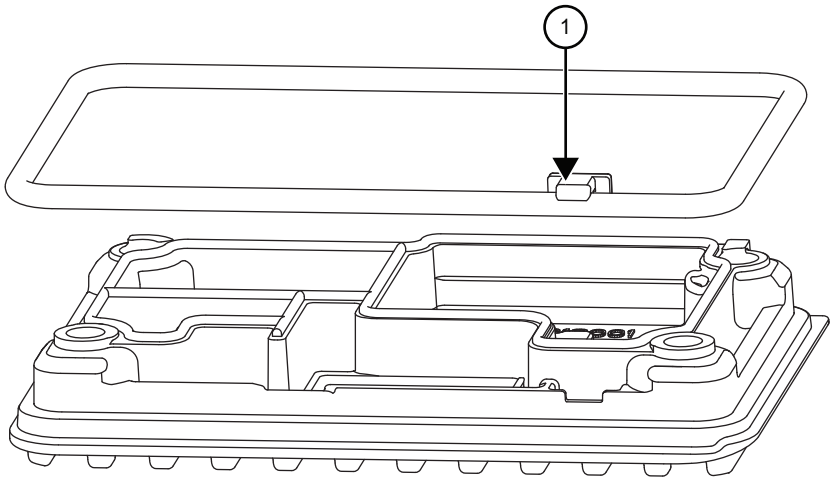
17 Install the GPS MMCX connector to the controller board. Ensure that the GPS cable is aligned in the GPS cable retention channel. Firmly press down the GPS MMCX connector to snap the connector into place. Press the cable down into the chassis pinch point. Do not press or pull the cable as damage may occur.

Figure 244: Installing GPS Connector to the Controller Board



18 Inspect and install the bottom cover seal onto the bottom cover. Ensure to correctly align the bottom cover seal tab to the bottom cover.

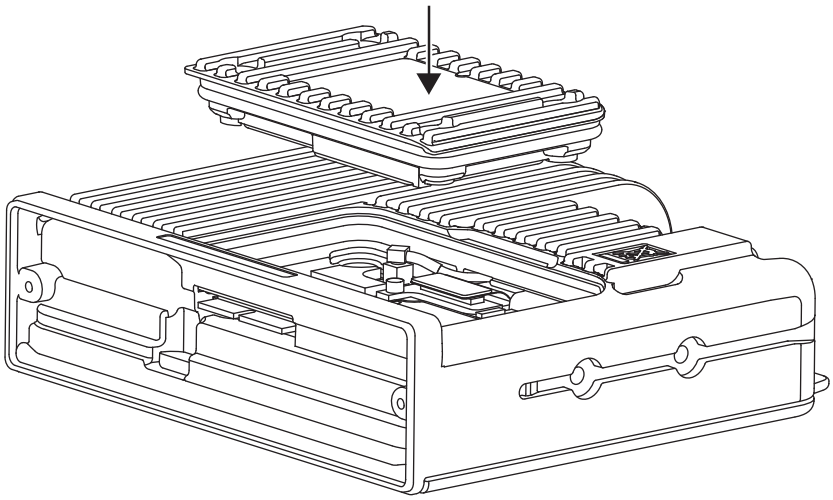
Figure 245: Inspecting and installing Bottom Cover Seal onto the Bottom Cover



No.	Description
1	Controller Cover Seal Tab

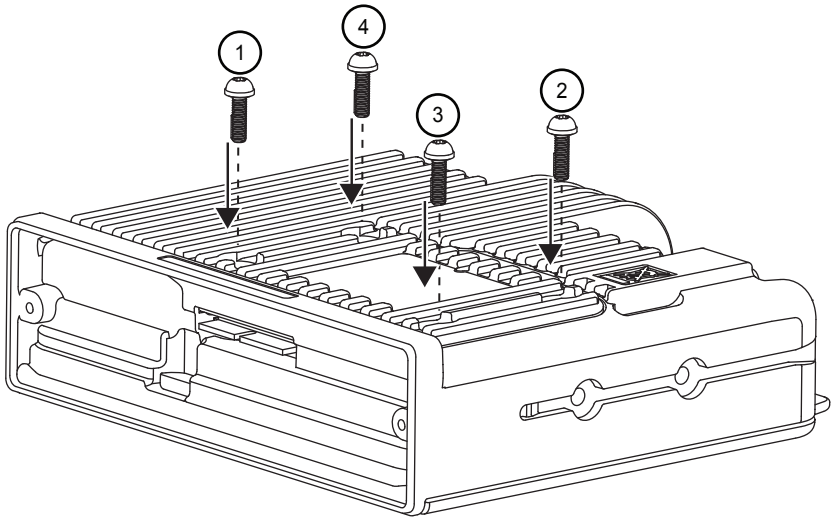
19 Place the bottom cover onto the chassis. Ensure that the bottom cover is properly aligned with the chassis. The bottom cover and chassis can be compressed together to squeeze seal into place.

Figure 246: Placing Controller Cover on the Chassis



20 Inspect the sealing washers on the four (4) bottom cover screws, and install the screws onto the bottom cover. Torque the bottom cover screws to 30 lbf-in, following the numbered sequence shown in the following figure, to ensure that the bottom cover is seated properly. Repeat the torque order sequence at least twice.

Figure 247: Placing the Controller Cover Screws



21 Once the bottom cover is fully installed, check the interface between the bottom cover and the chassis to ensure that the bottom cover seal is not pinched.

22 Attach the control head/TIB flex edge card connector to the edge card as described in Reassembling the O2 Control Head on page 283 for O2 Control Head, Reassembling the O7 Control Head on page 289 for O7 Control Head, and TIB Reassembly on page 290 for TIB. Ensure to properly align the edge card connector to the exposed edge card.

8.1.19.3
High Power Models

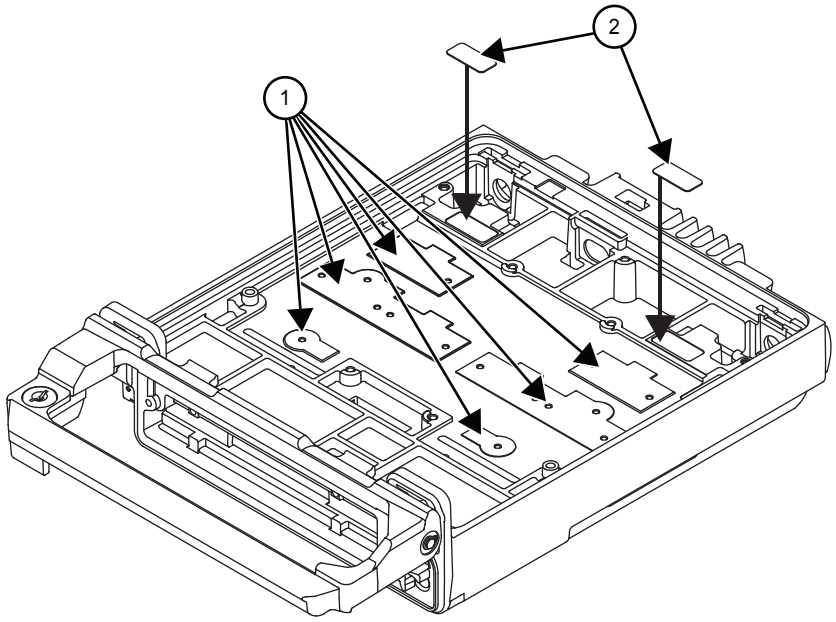
NOTE:
Prior to reassembling the radio, inspect all seals and sealing surfaces for damage (nicks, cuts, and so on) or dirt. Reseat all seals on their respective parts.

If Handle is removed, place handle into place. Slide a pivot pin into the handle and chassis opening from the middle of the radio. By using a snap ring pliers, place the snap ring onto the pivot pin. Ensure that the snap ring is fully seated in the pivot pin groove. Repeat on other side.

Procedure:

1 Begin with the chassis. Thoroughly inspect the chassis shield gasketing for damage and verify all chassis thermal pads are in place and free of damage. See Chassis Thermal Pad Replacement Procedure on page 293 to replace damaged pads. Reapply thermal grease to all RF board heat sinks. All heat sinks need to be covered with a smooth thin layer of thermal grease.

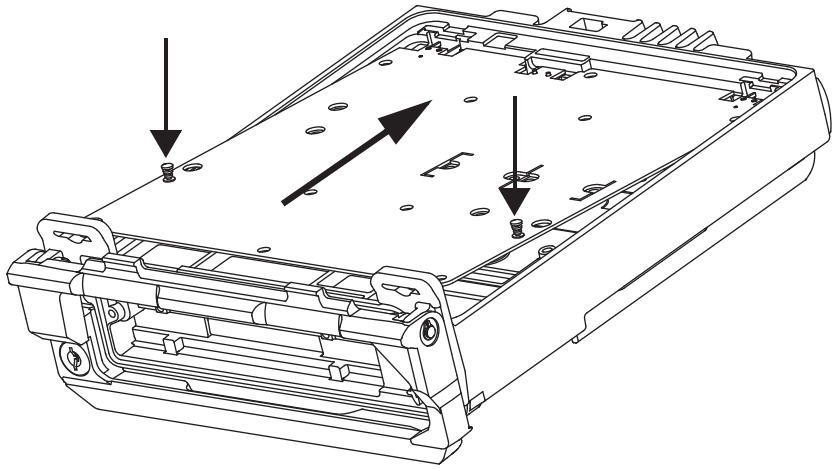
Figure 248: Inspecting the Chassis Shield Gasketing and Thermal Pads



1	Thermal Grease
2	Thermal Pads

2 Check that the one DC and two RF Connector seals on the RF Board are seated properly. Tilt the main board and slide it into place, taking care to line up the one (1) RF and two (2) DC connectors with the holes in the back of the chassis. Push back and down on the front of the main board to fully seat it. Ensure that the main board alignment holes are positioned over the chassis alignment bosses and that the main board is fully seated.

Figure 249: Inserting the RF Board into the Chassis



3 Insert the three RF/DC retention clips and fully seat them. The DC clip should be placed first, followed by the RF Clips. All Clips must be inserted before the board screws to properly locate the main board.

Figure 250: Inserting the RF/DC Retention Clips (Before)

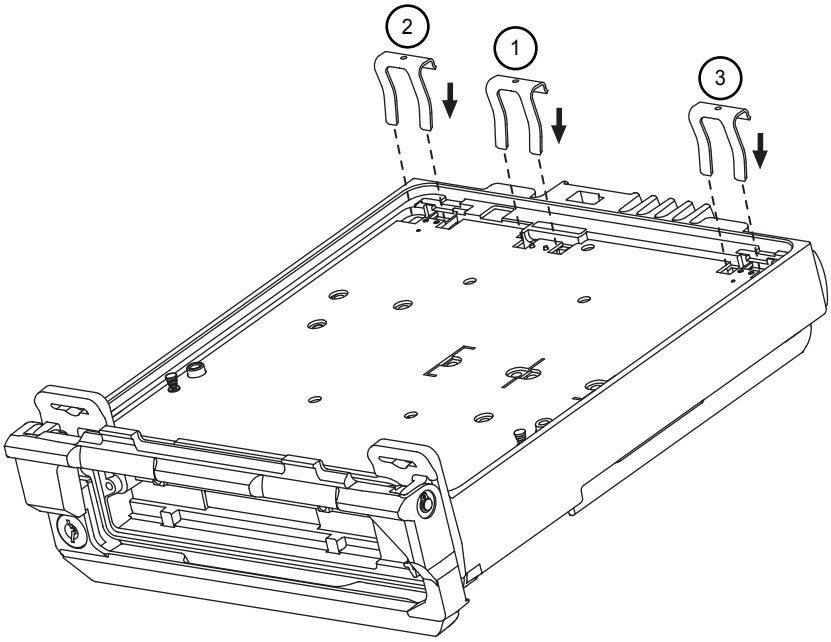
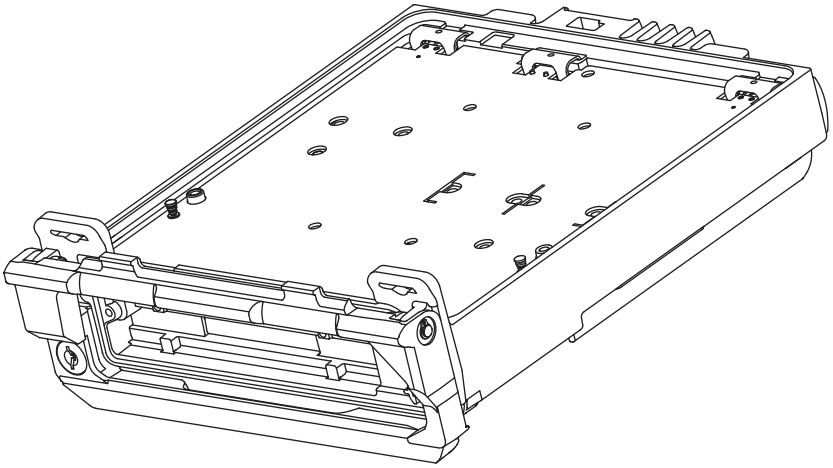


Figure 251: Inserting the RF/DC Retention Clips (After)



4 Insert and torque the PA screws to 12-14 in.-lbs. Start all screws prior to torquing them down (See Table 65: Number of PA Screws on page 276 for number of PA Screws).

Figure 252: Installing the PA Screws (HP/MP radio shown)

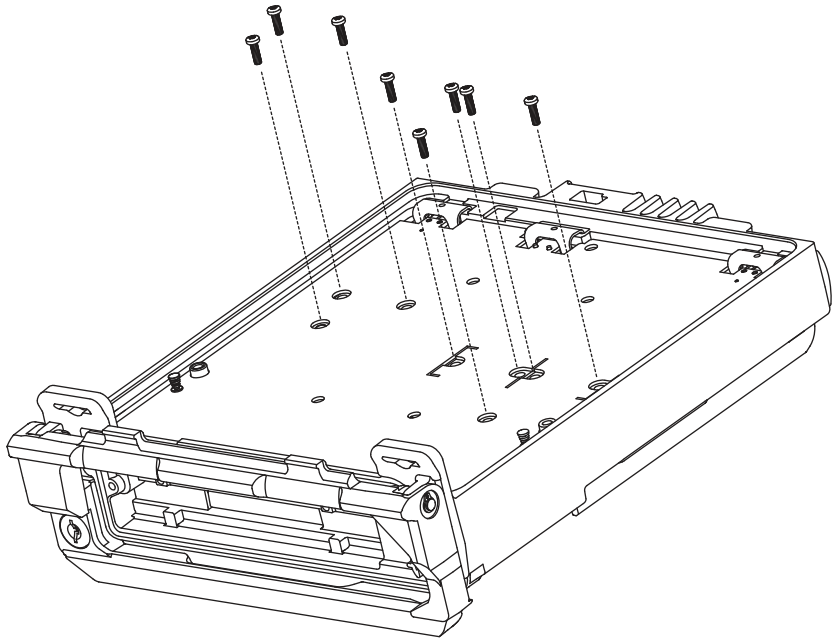
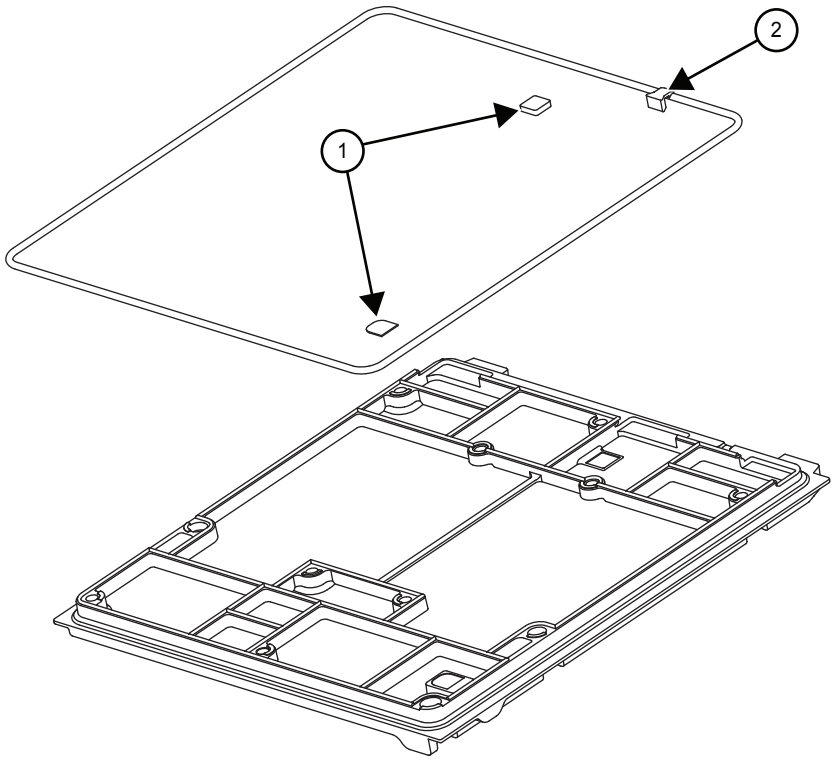


Table 65: Number of PA Screws

Band Description	Number of Screws
Single Band	5
Dual Band (Mid and High)	8
Dual Band (High)	10

5 Inspect RF cover for installation of the reverse polarity and voltage regulator thermal pads. Then inspect and properly seat the RF cover seal. Be careful to properly align the RF cover seal tab to the RF cover.

Figure 253: Inspecting the Thermal Pad and Installing the Cover Main Seal



1	Thermal Pads
2	RF Cover Seal Tab

6 Place the cover on the chassis and seat it properly. You can compress the cover and chassis together to squeeze the seal into place, seat the seal and make torquing the screws easier.

7 Inspect the sealing washers on the 12 top cover screws, and then torque down screws in the indicated order (see Figure 255: Torque Sequence on page 278). Torque down the screws to 34-36 in.-lbs.

NOTE: Repeat torque sequence at least twice to ensure a proper seating of the cover.

Figure 254: RF Screw Locations

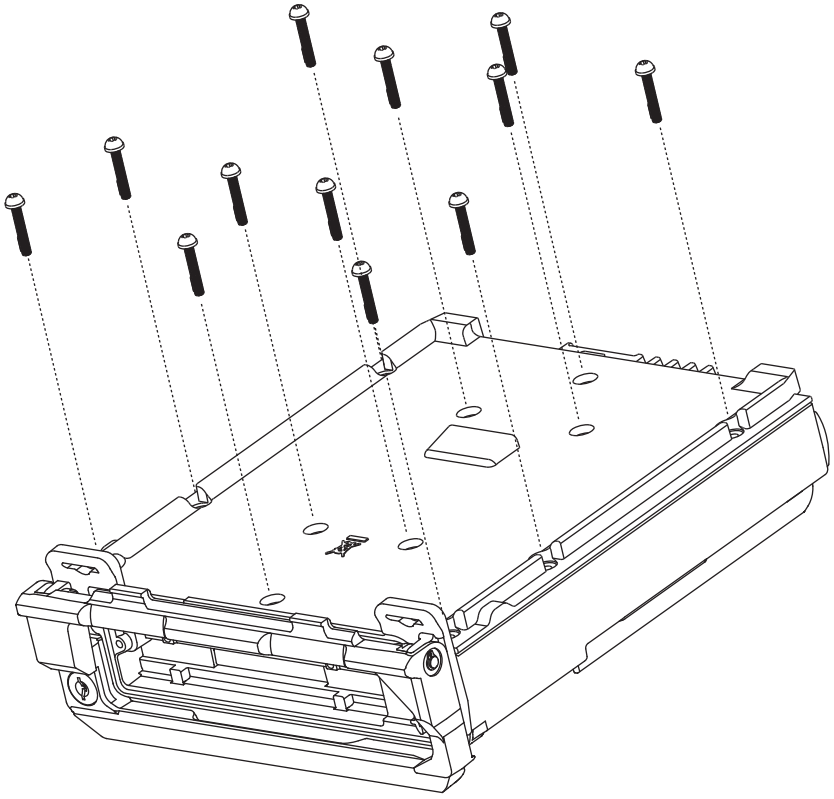
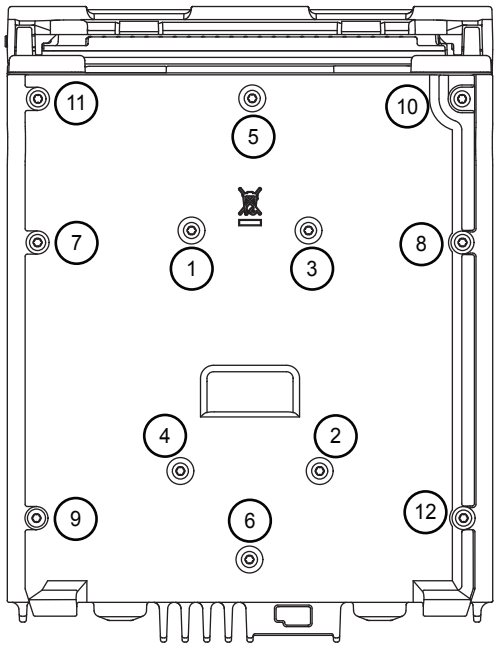
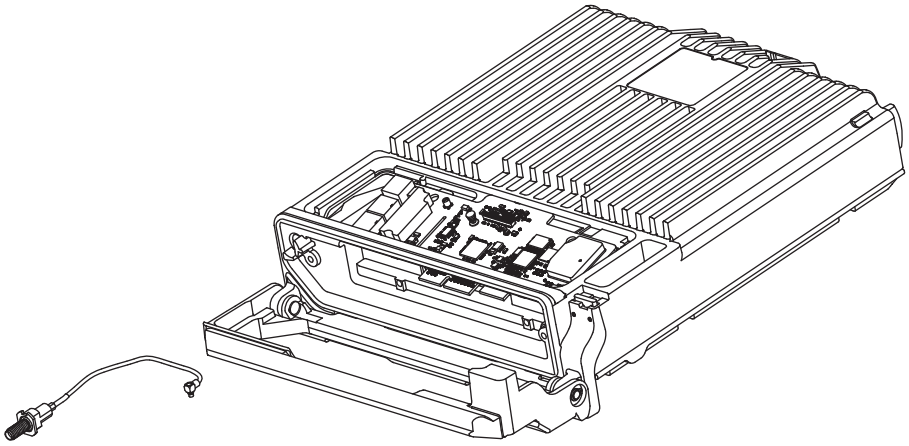


Figure 255: Torque Sequence



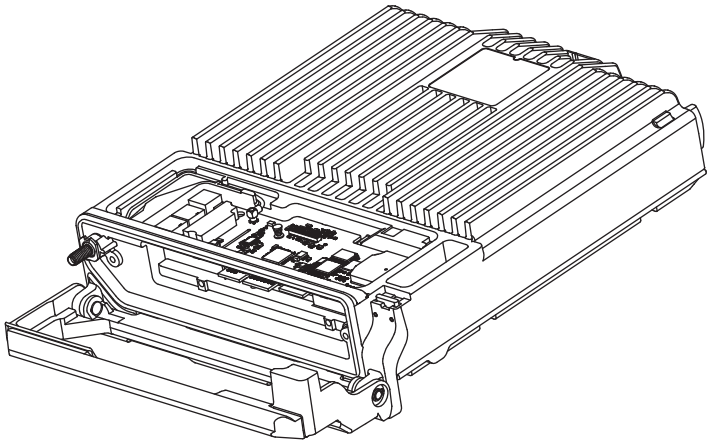
8 FLIP RADIO OVER: Install the controller board into the chassis by tilting controller board edge card through front opening using the controller board handle and then down into the chassis. Once controller board is placed in chassis, use the controller board handle to align controller board-to-board (BTB) connector to the RF BTB connector. Once aligned press down on controller board, in location shown, to connect the controller/ RF BTB connectors.

Figure 256: Inserting the Controller Board in the Chassis



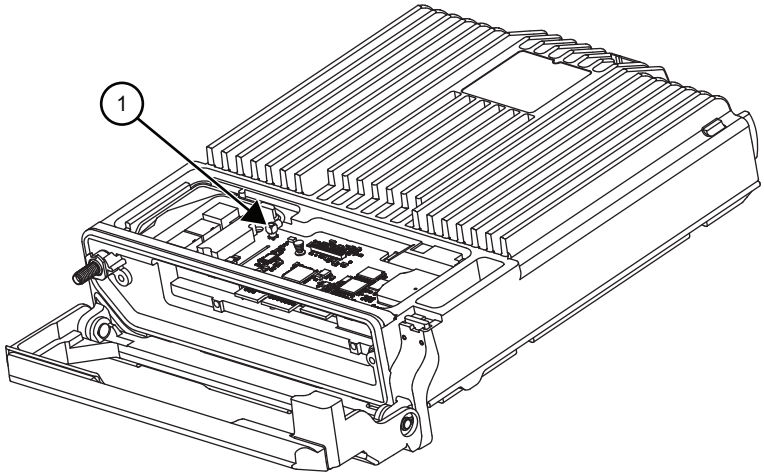
9 Install the GPS MMCX connector to the controller board. Be sure that GPS cable is aligned around GPS cable retention channel. Firmly press down on GPS MMCX connector to snap connector into place. After GPS connector is fully seated, press cable down into chassis pinch point. Do not pull directly on the cable as damage may occur.

Figure 257: Applying Thermal Grease to the Controller Board



10 Reapply thermal grease to the controller board heat sink. The heat sink needs to be covered with a smooth, thin layer of thermal grease.

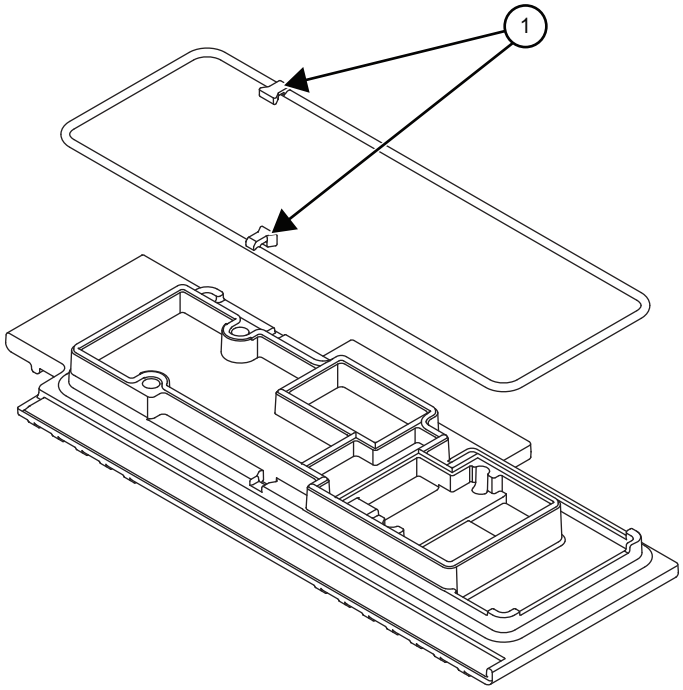
Figure 258: Inserting the GPS Connector to the Controller Board



1	Thermal Grease Area

11 Inspect and install controller cover seal onto the controller cover. Be sure to correctly align the two (2) controller cover seal tabs to the controller cover.

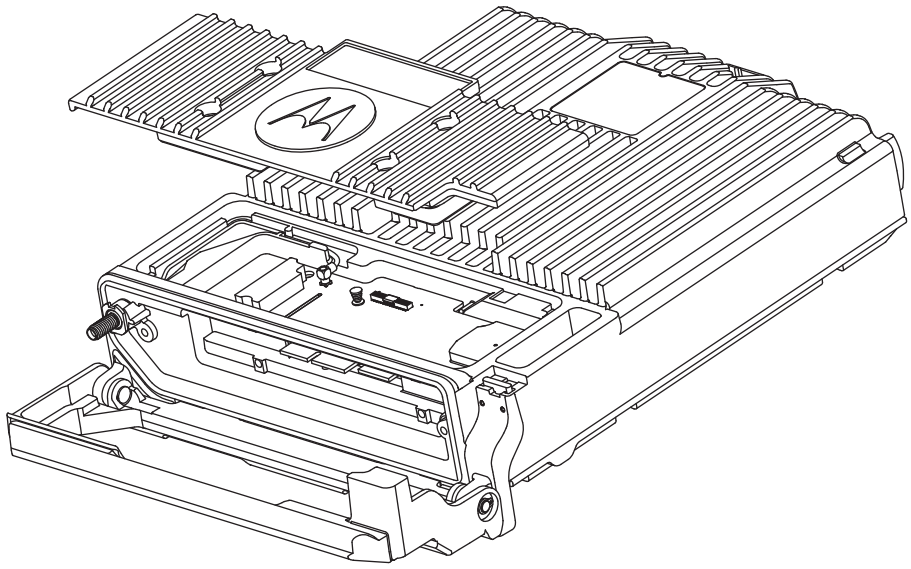
Figure 259: Inspect and Install Controller Cover Seal onto the Controller Cover



1	Controller Cover Seal Tab

12 Place the controller cover onto the chassis. Be sure that controller cover is properly aligned to chassis. The controller cover and chassis can be compressed together to squeeze seal into place.

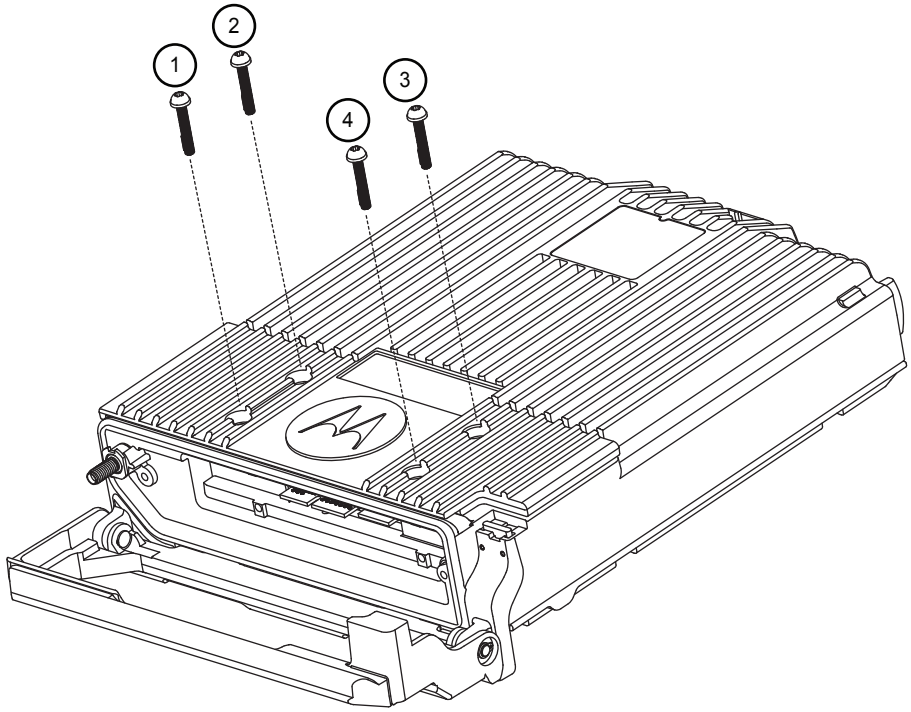
Figure 260: Place the Controller Cover onto the Chassis



13 Inspect sealing washers on four (4) controller cover screws, and then install the screws onto controller cover. Torque the controller cover screws to 34-36 in-lbf, be sure to torque screws starting with the bottom left and going around clockwise.

NOTE: Repeat torque sequence at least twice to ensure a proper seating of the cover.

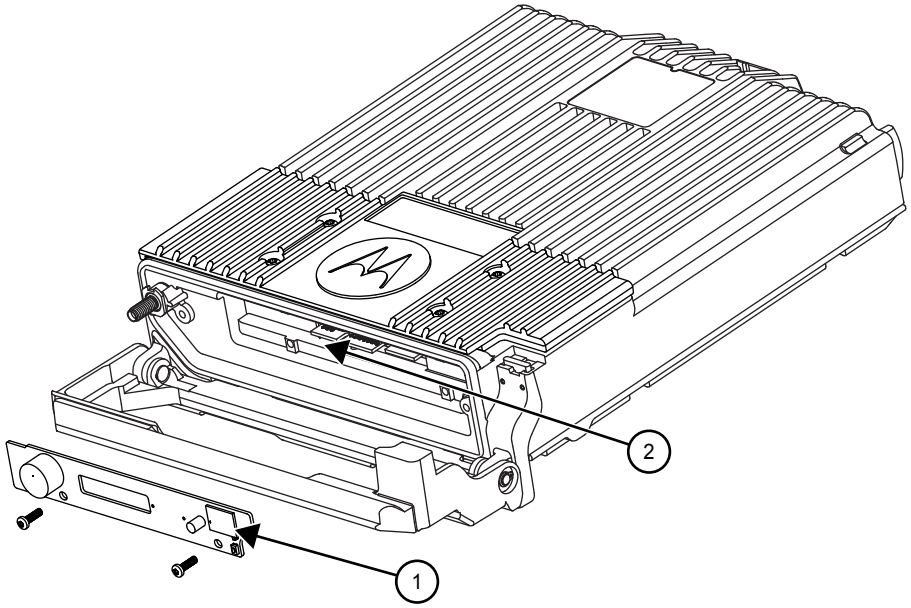
Figure 261: Securing the Controller Cover to Chassis



14 Once controller cover is fully installed check controller cover-chassis interface to ensure that the controller cover seal is not pinched. For Radios not equipped with an option board, skip to step 17.

15 Install the option board onto the front of the chassis by using the option board handle and plugging the option board edge card connector in to the shorter, single exposed edge card.

Figure 262: Installing the Option Board



1	Option Board Handle
2	Option Board Edge Card

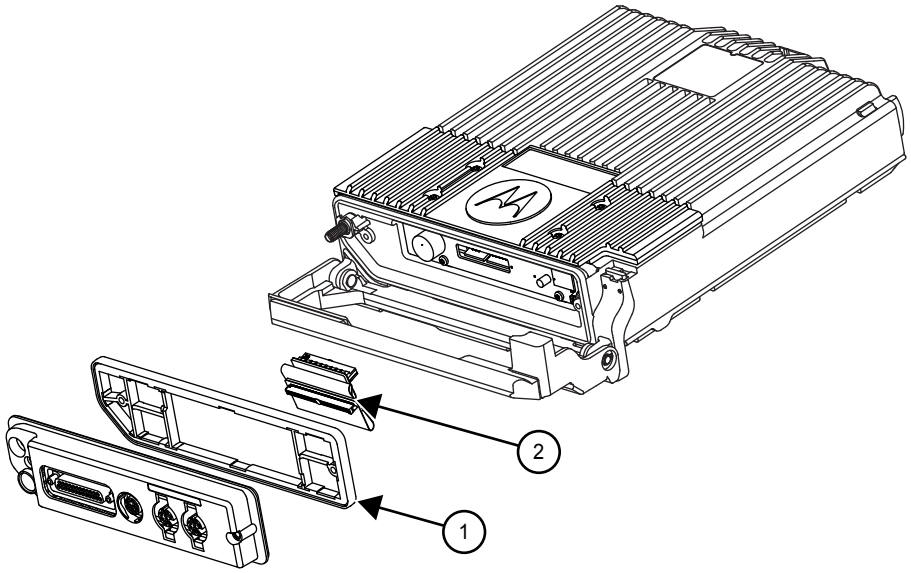
16 Install the two (2) option board screws using a T-10 Torx bit. Torque the option board screws to 6-8 in-lbf.

17 Install frame seal to TIB. Compress to TIB and frame seal together to fully seat.

18 Install flex to TIB. Be sure to properly align connectors before connecting.

19 Attach the flex edge card connector to edge card. Be sure to properly align edge card connector to exposed edge card.

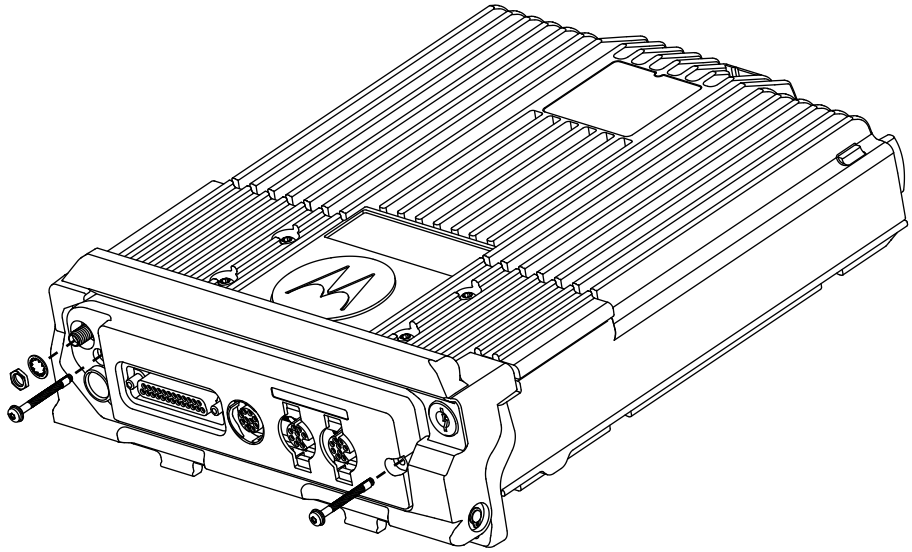
Figure 263: Attaching the Flex Edge Card Connector



1	Frame Seal
2	Flex Edge Card Connector

20 Align TIB to front of chassis using the frame seal. Install two (2) TIB screws. Be sure the TIB screws each have one (1) washer and one (1) seal installed. Torque down TIB screws to 8-10 in-lbf. Secure the GPS SMA connector using the washer and nut. Seat the nut using a 5/16” nutdriver and torquing it down to 7-9 in-lbf. Align plug to TIB opening and press down to seat.

Figure 264: Installing the Control Head/TIB



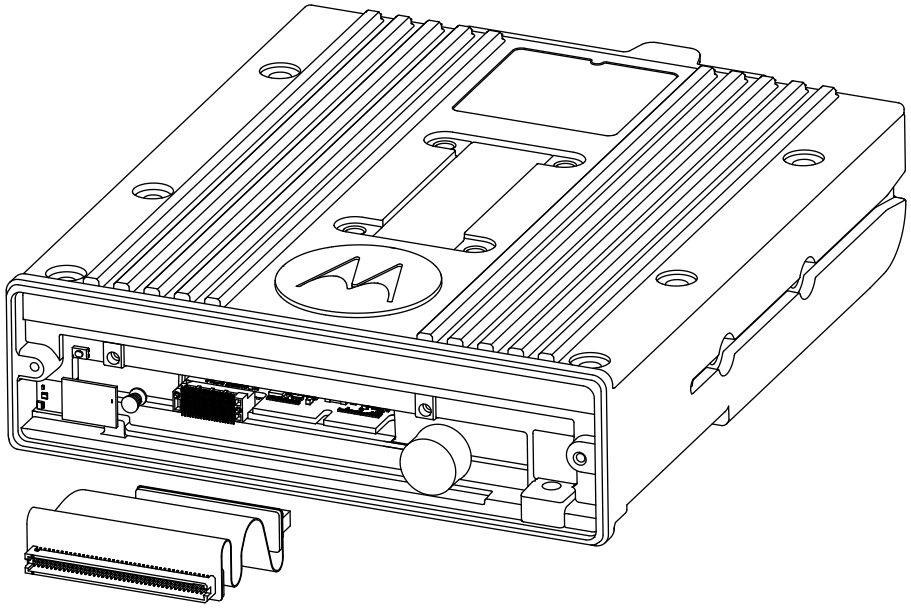
8.1.19.4

Reassembling the O2 Control Head

Procedure:

1 Grasp the handle on the transceiver end of the transceiver flex and plug the flex into the 50-pin connector on the side of the main board.

Figure 265: Installing the Transceiver Flex onto the Transceiver

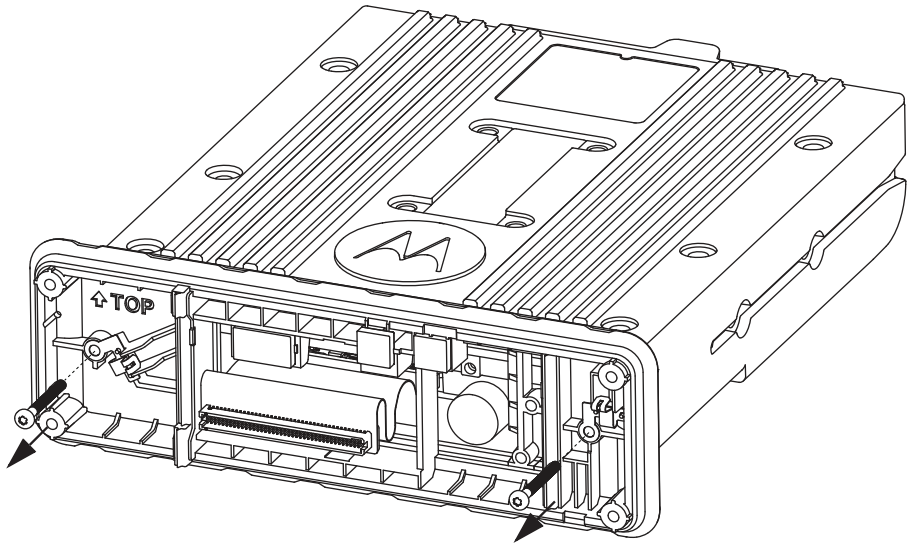


2 Align the I-seal with the back housing assembly, and push the I-seal into place.

3 Align the back housing assembly with the transceiver, thread the flex through the back housing assembly, and push the back housing assembly into place.

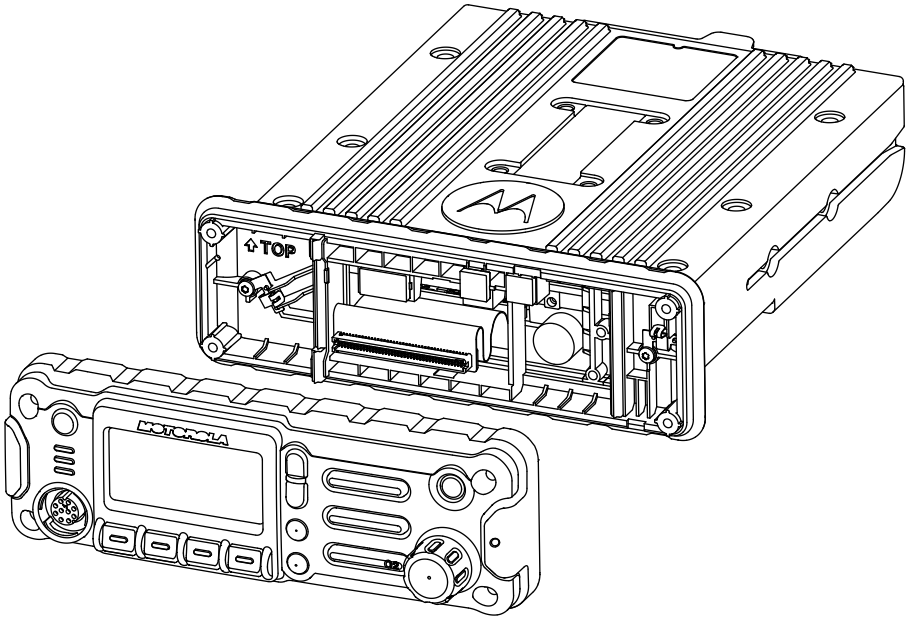
4 Secure the back housing assembly to the transceiver with two new transceiver screws using the T10 torx bit. Apply 13 in. lbs. of torque for each screw. Simultaneously, firmly press down on the center of the back housing to provide sufficient compression to the I-seal during assembly.

Figure 266: Installing the Back Housing Assembly onto the Transceiver



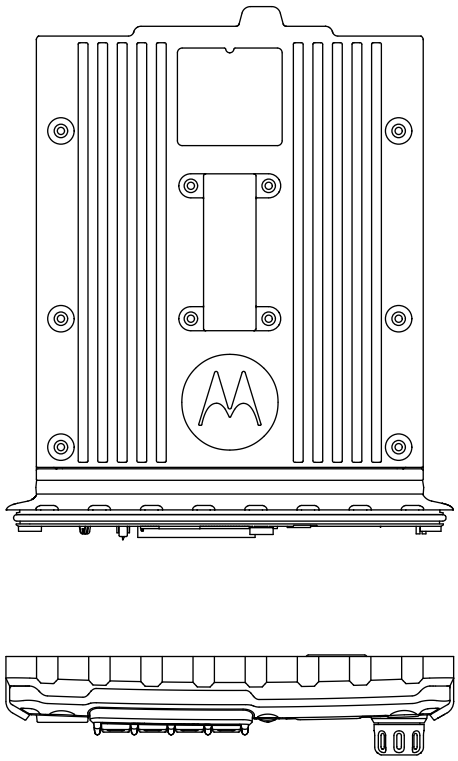
5 Reinstall the transceiver flex onto the front housing assembly or TIB flex onto the TIB connector.

Figure 267: Installing the Transceiver Flex onto the Front Housing Assembly



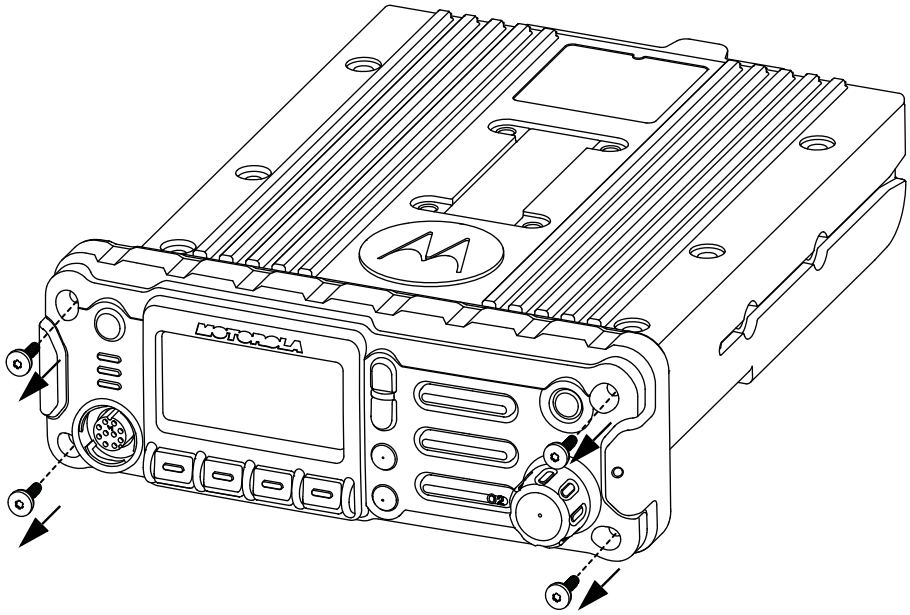
6 Attach the front housing assembly to the back housing assembly.

Figure 268: Attaching the Front Housing Assembly to the Back Housing Assembly



7 Secure the front housing assembly to the back housing assembly with four new control head screws using the T20 torx bit. Apply 9 in. lbs. torque for each screw.

Figure 269: Attaching the Control Head Screws



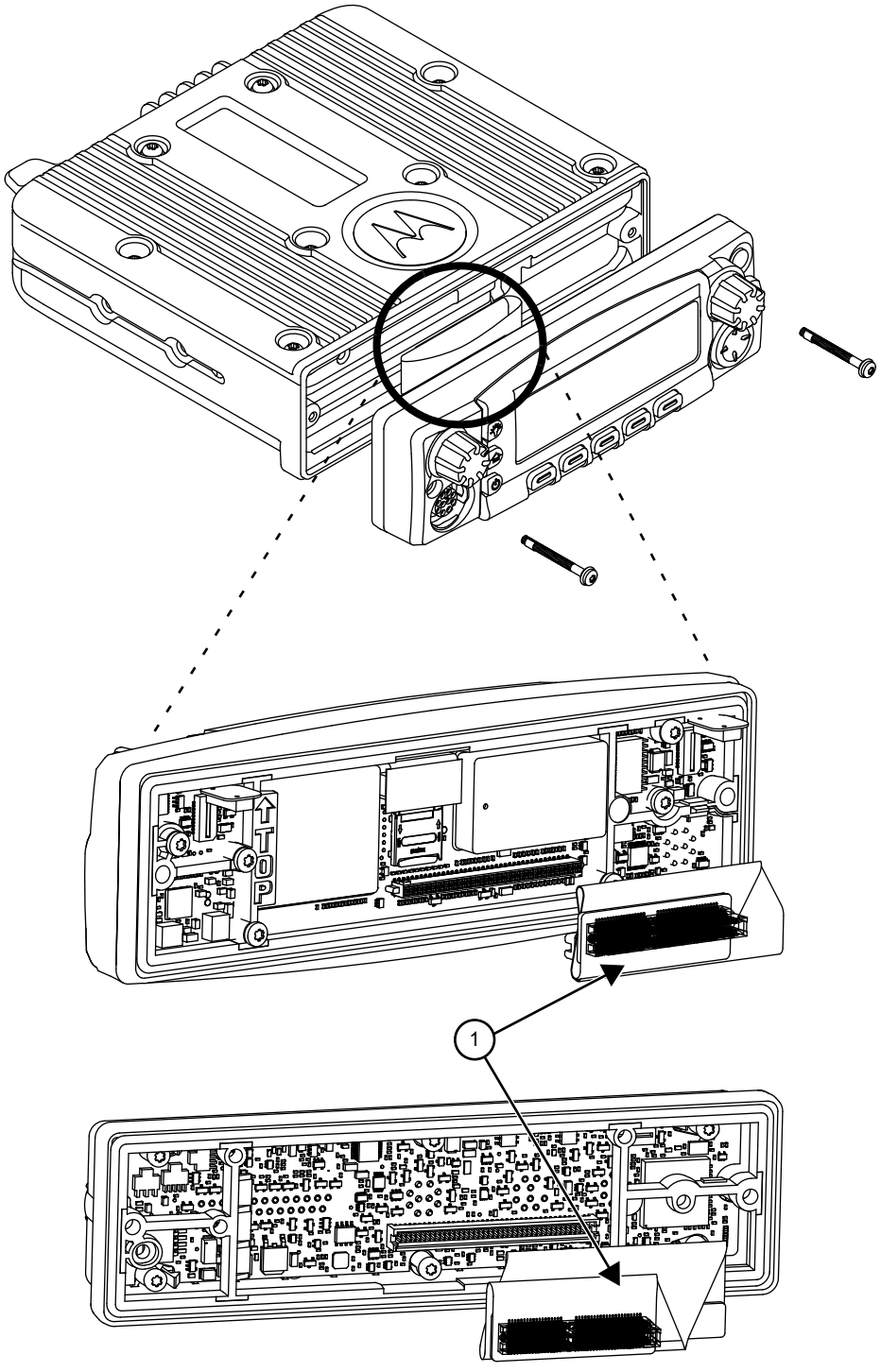
8.1.19.5

Reassembling the O5 Control Head

Procedure:

1 Attach the control head/TIB flex edge card connector to the edge card. Be sure to properly align the edge card connector to the exposed edge card.

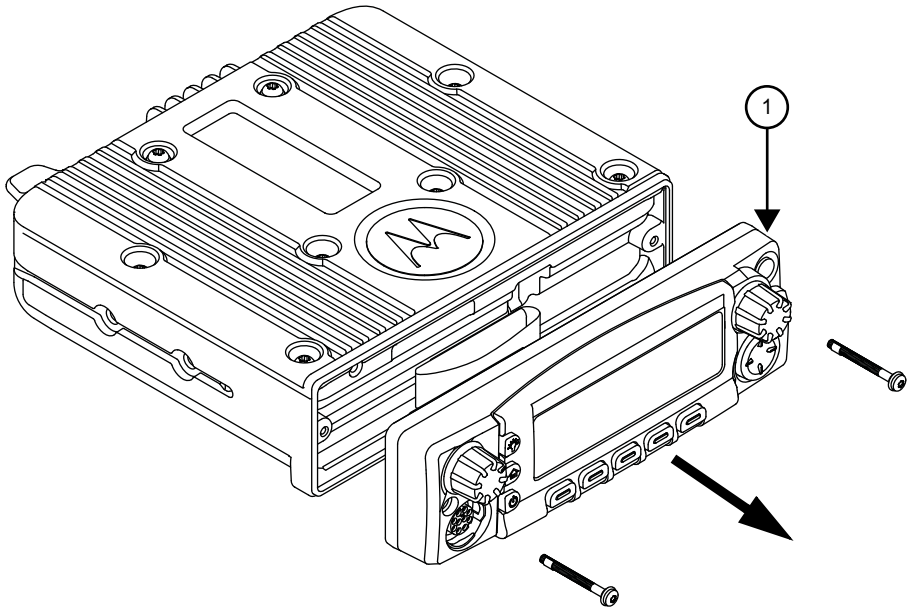
Figure 270: Installing Flex into the Controller PCB



1	Control Head Flex

2 Install the control head/TIB flex to the control head/TIB. Be sure to properly align the connectors.

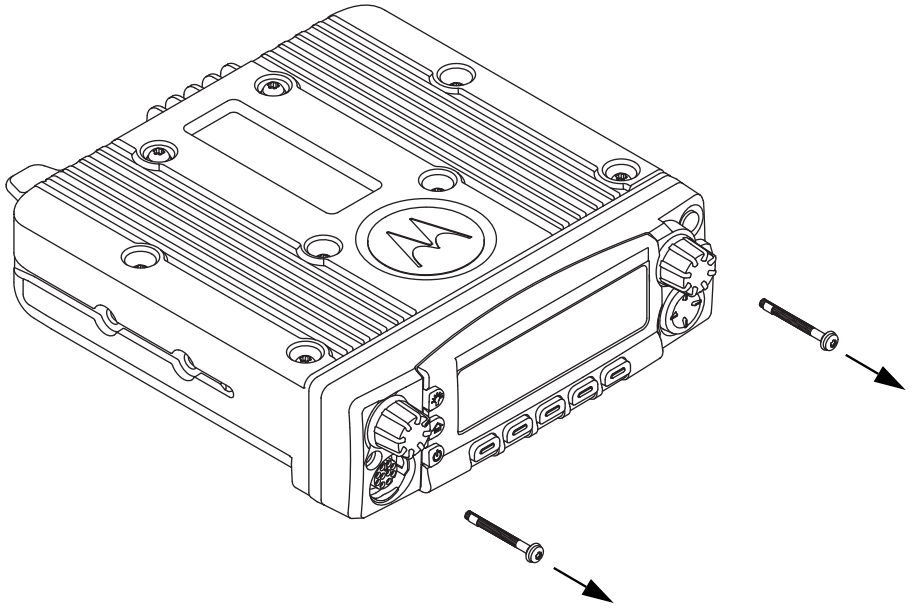
Figure 271: Installing Control Head/TIB Flex to the Control Head/TIB



1	Control Head

3 Align the control head/TIB to the front of the chassis using the frame seal. Install two (2) control head/TIB screws. Be sure the control head/TIB screws each have one (1) washer and one (1) seal installed. Torque down the control head/TIB screws to 8-10 in-lbf.

Figure 272: Aligning Control Head/TIB Front of Chassis, and Installing the Control Head/TIB Screws



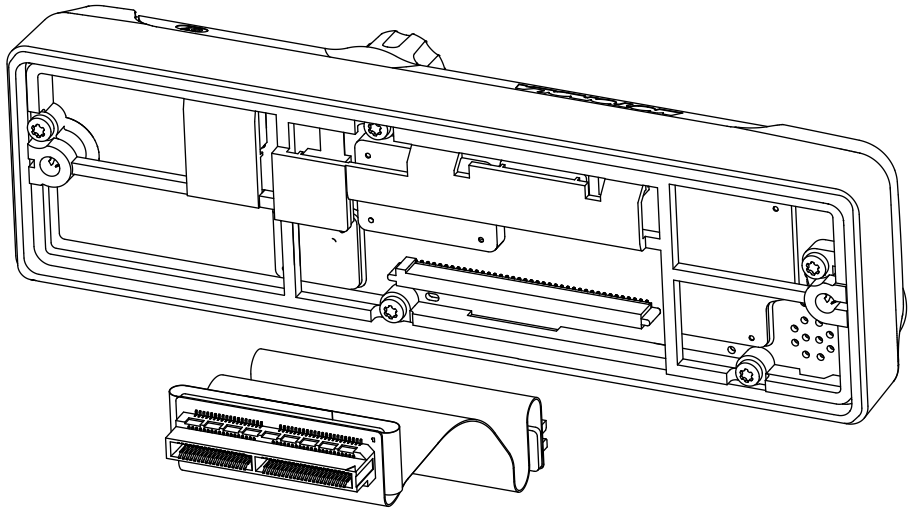
8.1.19.6

Reassembling the O7 Control Head

Procedure:

1 Reinstall the transceiver flex onto the control head or TIB flex onto the TIB connector.

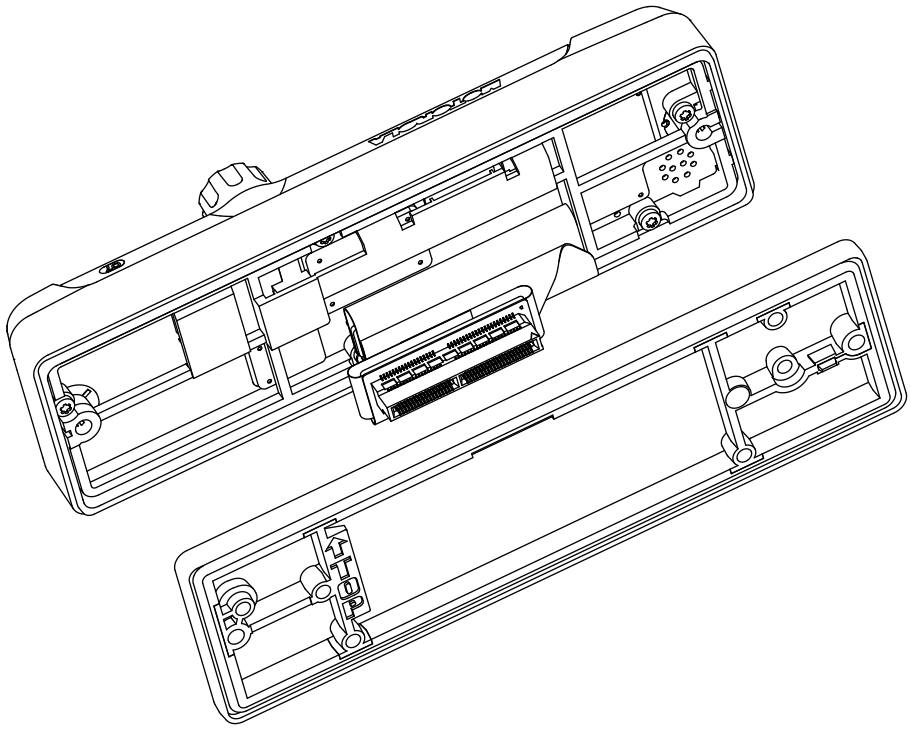
Figure 273: Installing the Transceiver Flex onto the Control Head



2 Align the I-seal with the control head and push the I-seal into place.

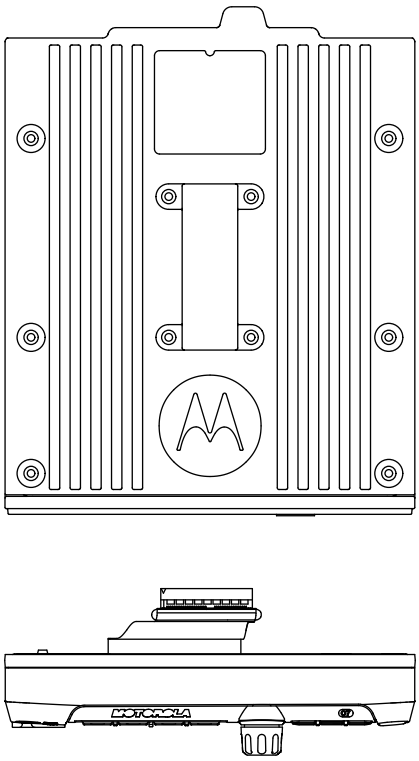
NOTE: Be careful not to damage the transceiver flex when pushing the I-seal into place.

Figure 274: Attaching the I-seal to the Control Head



3 Grasp the handle at the end of the transceiver flex and plug the flex into the 50-pin connector on the main board side.

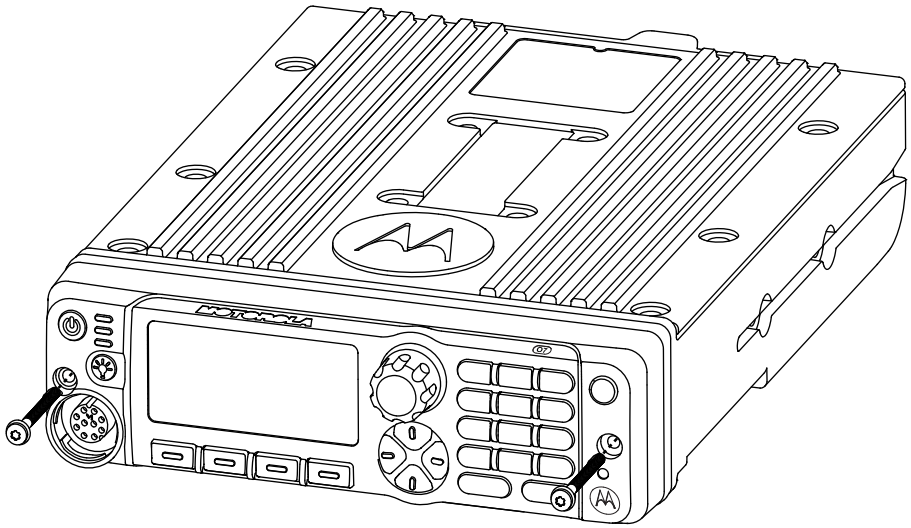
Figure 275: Attaching the Control Head to the Transceiver



4 Align the control head with the transceiver and push the control head into place on the transceiver.

5 Secure the control head to the transceiver with two new transceiver screws using a T10 torx bit. Apply 9 in/lbs. torque for each screw.

Figure 276: Attaching the Transceiver Screws

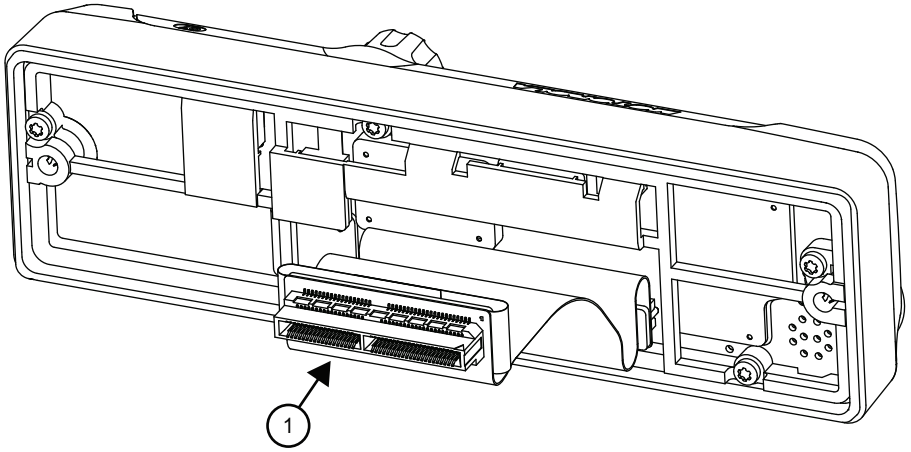


8.1.19.7
TIB Reassembly

Procedure:

1 Reinstall the TIB flex/remote mount flex onto the TIB connector.

Figure 277: Reinstalling TIB Flex/Remote Mount Flex

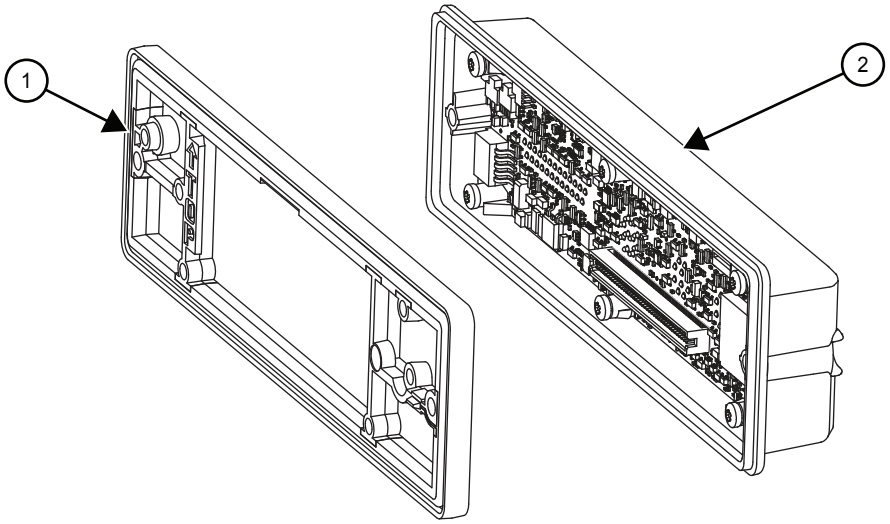


1	Transceiver Flex

2 Align the I-seal with the TIB and push the I-seal into place.

NOTE: Be careful not to damage the remote mount flex when pushing the I-seal into place.

Figure 278: Aligning and placing the I-Seal

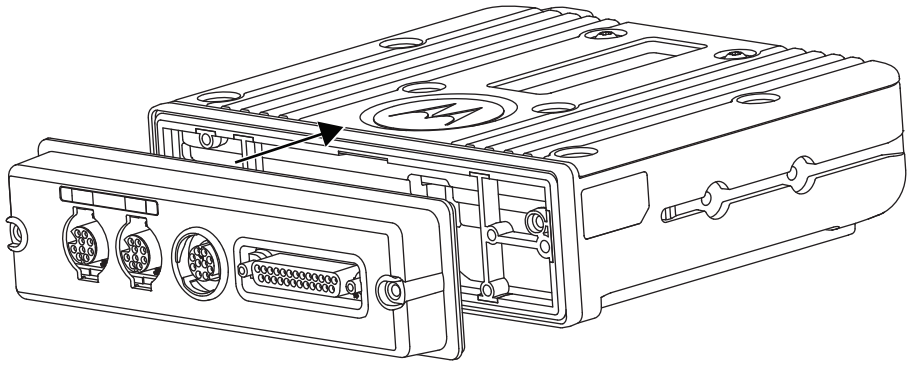


1	Frame Seal
2	TIB

3 Grasp the handle at the transceiver end if the remote mount flex and plug the flex into the edge-card on main board side.

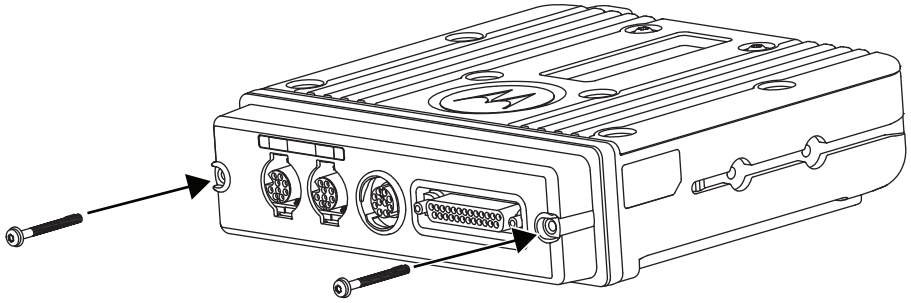
4 Align the TIB with transceiver and push the TIB into place on the transceiver.

Figure 279: Aligning and Placing TIB on Transceiver



5 Secure the TIB to the transceiver with two (2) new TIB screw using T-10 Torx bit. Apply 9 in.lbs torque for each screw.

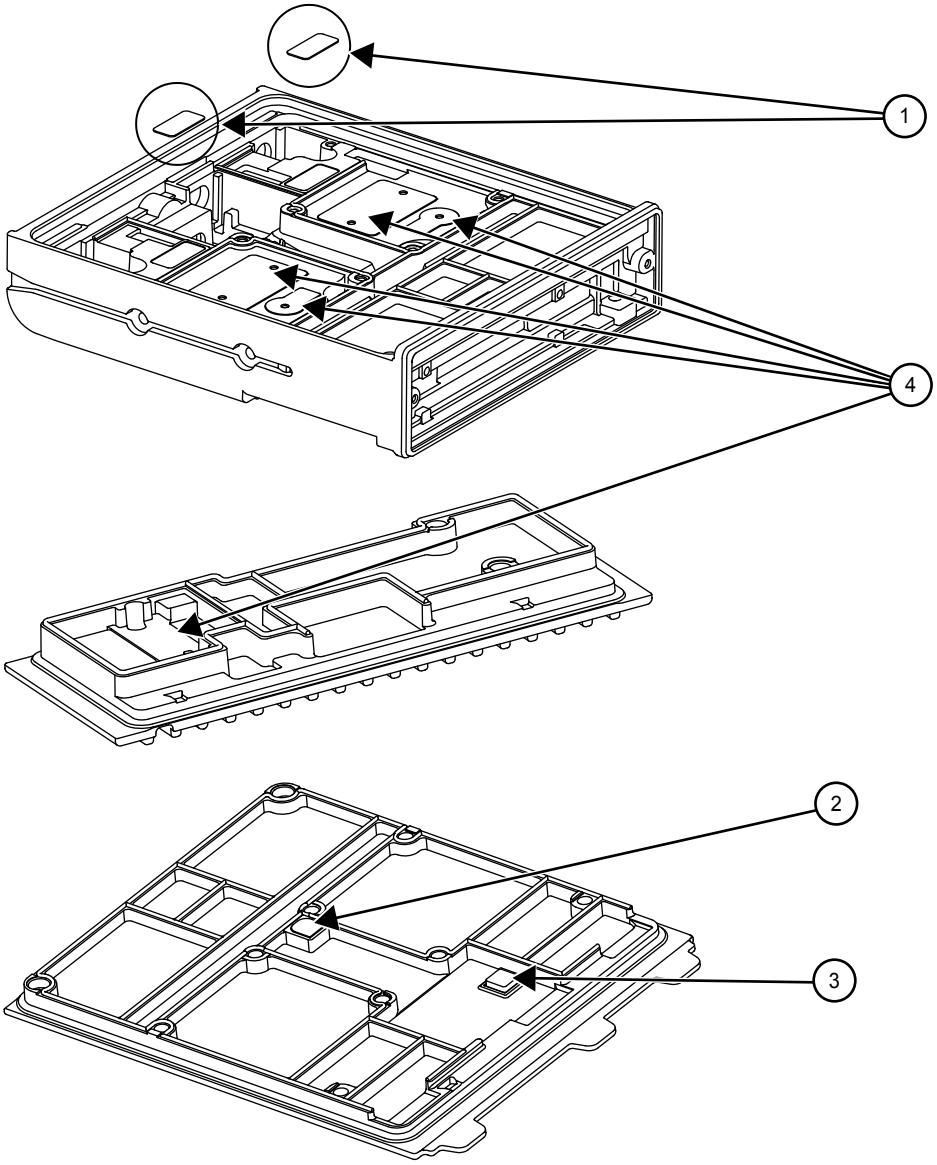
Figure 280: Installing the TIB screws



8.2
Chassis Thermal Pad Replacement Procedure

8.2.1
Mid Power Models

Figure 281: Chassis Thermal Pad and Grease Locations



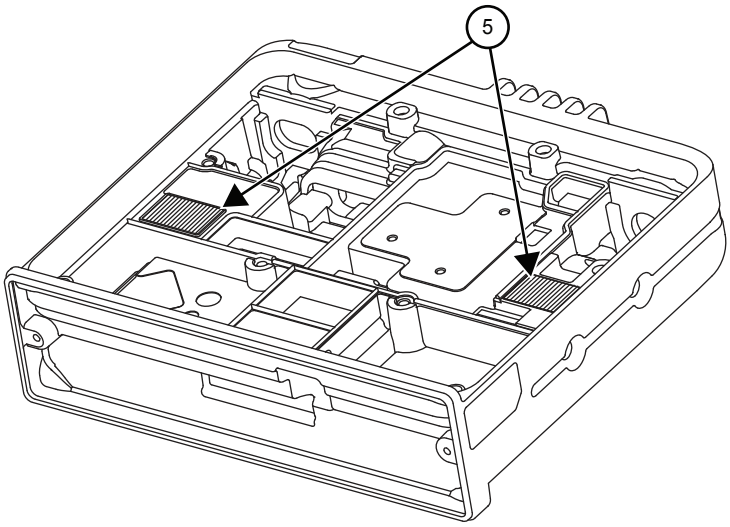


Table 66: Chassis Thermal Pad and Grease Part Numbers

Item No.	Part No.	Description
1	7575935B01	Pad, Thermal, Harmonic Filter
2	7575767B01	Pad, Thermal, Regulator
3	7585060F01	Pad, Thermal, Reverse Polarity
4	1110022D23	Thermal Grease
5	75012190001	APX 2500/4500/4500Li/1500 Thermal Pad

Procedure:

1. Use a plastic flat-edge tool (like a black-stick solder aid) to lift the pad from the chassis surface.
2. Discard the old pad. Use a soft cloth to remove any remaining residue. Alcohol can also be used, if necessary. Care should be taken to minimize any cleaning-agent contact with the surrounding shield gasket.
3. Once the surface is clean and dry, use tweezers to remove a new pad from the shipping liner, and place it yellow-side down on the chassis.
4. Apply pressure to the pad to activate the pressure-sensitive adhesive. If applicable, remove the blue liner with tweezers (Thermal pad P/N: 7585060F01 and P/N: 75012190001 do not have a blue liner).

CAUTION: Use of a metal tool will scratch the heat sink surface and reduce the thermal effectiveness of the thermal pad which is used to heat sink heat-sensitive components. Loss of thermal effectiveness of the thermal pads could result in the overheating of heat-sensitive radio components and result in their damage.

8.2.2

High Power Models

Figure 282: Chassis Thermal Pad and Grease Locations

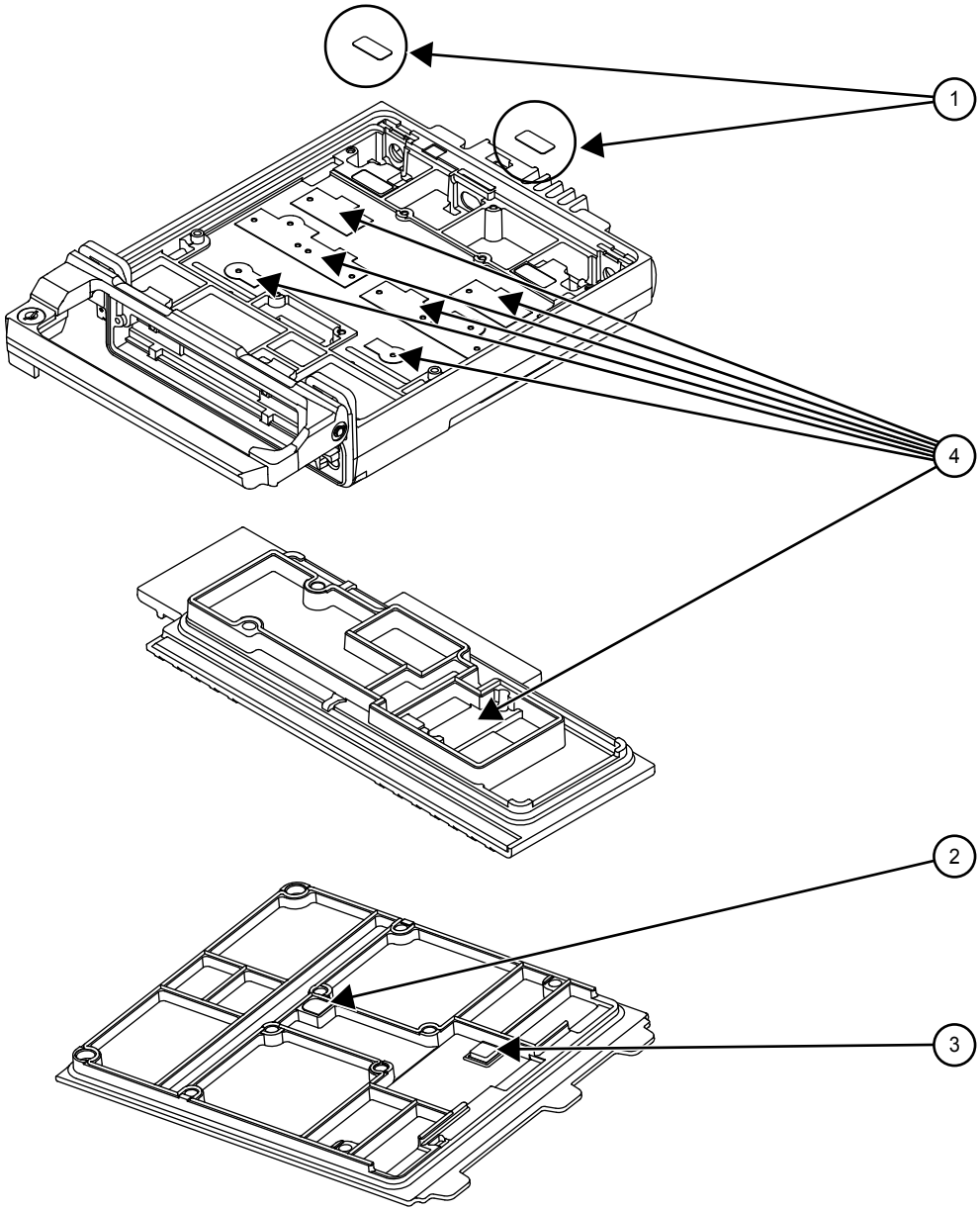


Table 67: Chassis Thermal Pad and Grease Part Numbers

Item No.	Part No.	Description
1	7575935B01	Pad, Thermal, Harmonic Filter
2	7575767B01	Pad, Thermal, Regulator
3	7585060F01	Pad, Thermal, Reverse Polarity

Item No.	Part No.	Description
4	1110022D23	Thermal Grease

Procedure:

1. Use a plastic flat-edge tool (like a black-stick solder aid) to lift the pad from the chassis surface.
2. Discard the old pad. Use a soft cloth to remove any remaining residue. Alcohol can also be used, if necessary. Care should be taken to minimize any cleaning-agent contact with the surrounding shield gasket.
3. Once the surface is clean and dry, use tweezers to remove a new pad from the shipping liner, and place it yellow-side down on the chassis.
4. Apply pressure to the pad to activate the pressure-sensitive adhesive. If applicable, remove the blue liner with tweezers (Thermal pad P/N: 7585060F01 does not have a blue liner).

8.3

Fastener Torque Chart

The following table lists the various fasteners by part number and description, followed by the torque values and the location where used. Torque all fasteners to the recommended value when assembling the radio.

Table 68: Fastener Torque Chart

Part Number	Description	Repair Torque (in.–lbs.)	Locations Used In A Radio
0310909A33	Screw, Torx M3x10	6–8	RF Board / *Option Board Slot / *Accessory Connector to Chassis
0385870E01	Screw, Torx M4.0xP0.7x25	34–36	*RF Covers and *Controller Covers
0364332H02	Screw, Torx M3.0xP0.5x32.5	8–10	TIB to Chassis / O5 Control Head
0371838H01	Screw, Torx M2.5xP0.45x12.0	6–8	Accessory Connector to External Chassis
0310909F21	Screw, Torx M3x16	6–8	TIB
0371859H01	Screw, Torx M6.0xP1.0x25.0	50–52	*Trunnion Mounting
02009258001	GPS Hex Nut	7–9	*GPS Connector
0104054J54	Screw, Torx M4.0xP0.7x15.0	29–31	APX 2500/4500/4500Li/ 1500 Top and Bottom Cover
03012052001	Screw, Torx M3.0xP0.5x26.0	12–14	O2 Rear Housing
03012063001	Screw, Torx M4.0xP0.7x18.0	8–10	O2 Front Housing

Part Number	Description	Repair Torque (in.–lbs.)	Locations Used In A Radio
03012062001	Screw, Torx M3.0xP0.5x38.0	8–10	O7 Control Head
0310944A14	Screw, Torx M3.12xP1.27x16.0	8.8–9.2	Remote Rear Assembly Screws

NOTE: * Is only applicable for APX 5500 / APX 6500 / APX 7500 / APX 6500Li

Chapter 9

System Level Diagnostics and Basic Radio Analysis

This chapter contains pin-out information for the radio, error codes, and system level troubleshooting suggestions.

This section help you to isolate a problem to the board level. Board-level troubleshooting does not attempt to isolate problems to the component level. Component-level service information can be found in the APX Mobile Radios And O3, O5 & O9 Detailed Service Manual. (See the Related Publications on page 27 section of this manual for the specific manual number.)

NOTE: To access the various connector pins, use the housing eliminator/test fixture along with the diagrams found in this section of the manual. (See the Service Aids and Recommended Tools on page 118 section for the appropriate Motorola Solutions service aids and tools parts numbers.)

CAUTION: With the exception of some inputs on service monitors, a suitable attenuator rated at 100 W or more should always be used with all test equipment connected to the RF connector. Failure to do so can result in test equipment damage.
When performing both transmit and receive tests, it is still possible that equipment might be damaged by the radio transmitter. This could occur under the following conditions: trunking-mode affiliation, missing emergency jumper, a defective PTT button, unintentional PTT activations, or circuit board malfunction. Therefore, an attenuator is always recommended.

9.1 External Connectors

This section describes the external connectors that are supported on this radio.

9.1.1 J1 – Mobile Microphone Port (MMP)

NOTE: Not applicable for O3 control head.

The MMP connector is located on the control heads and the transceiver interface board (TIB).

Table 69: MMP Connector Signal Descriptions on page 299 describes the name and function of each pin.

Figure 283: MMP Connector

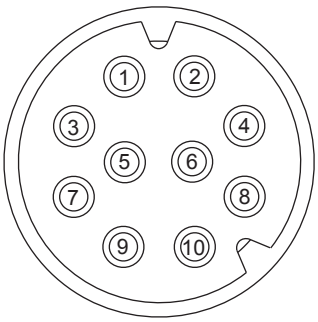


Table 69: MMP Connector Signal Descriptions

Pin #	Pin Name		Pin Function
	Control Head (J1)	TIB (J700)	
1	1-Wire®	1-Wire®	Signal used to identify accessory.
2	PTT	PTT_GPIO3	Active low Push-To-Talk input. Asserting this input results in MIC_HI microphone input use. Distinguished from PTT at the TIB J600 or rear J2 connector, which uses the AUX_MIC microphone input.
3	SPK	SPK	Receive audio out designed to drive a 150 Ω load.
4	USB_D-/ RS232_RX_5v	USB_D-/ RS232_RX_5v	Multiplexed USB D- and RS232 receive signal. The interface used is based on a 1-Wire® read of the connected accessory. The RS232 signals are CMOS levels, 0-5 V.
5	GND	GND	Ground.
6	VBUS/OPT_5V	VBUS/OPT_5V	On both the control head and the TIB, when the MMP port is configured as a device, this is the VBUS input used for enumeration. When the MMP port is configured as a host, this is the VBUS output, capable of sourcing 500 mA.
7	MIC_HI	MIC_HI	Microphone audio input (80 mV rms nominal) associated with the PTT signal at pin 2. Distinguished from AUX_MIC at the TIB J600 or rear J2 connector.
8	USB_D+/ RS232_TX_5v	USB_D+/ RS232_TX_5v	Multiplexed USB D+ and RS232 transmit signal. The interface used is based on a 1-Wire read of the connected accessory. The RS232 signals are CMOS levels, 0-5 V.
9	HUB/KEYFAIL	KEYFAIL/GPIO_4	Multiplexed HUB and KEYFAIL lines on the control head. The TIB has KEYFAIL or GPIO_4 functionality.
10	GPIO_0	GPIO_0	General purpose I/O 0.

9.1.2
J2 Mid Power Transceiver – Data and Audio Rear Interface

J2 or MAP interface is located at the back of the radio.

The following figure and table illustrate the connector and the function of each pin. Order the Male crimping pin according to the wire gauge for the accessory. Order part number 3980034F05 for 22–28 gauge wire and 3980034F04 for 18–20 gauge wire.

Figure 284: J2 Rear Accessory Connector

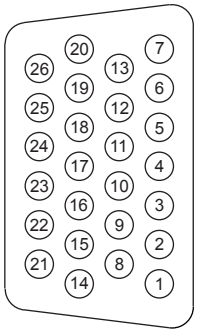


Table 70: J2 Rear Accessory Connector Signal and Voltage Descriptions

Pin #	Pin Name		Pin Function
1	GROUND	Ground	Preferred ground for any digital lines on J2.
2	BUS+ or USB2+ or RS232_TX_5V	SB9600 BUS+ or USB2+ or RS232 Transmit	Part of the Motorola Solutions SB9600 communications bus to connect external devices. It s also used for the USB host interface or 5v RS232_TX. Defaults to BUS+. Idles at +5 V.
3	BUS- or USB2- or RS232_RX_5V	SB9600 BUS- or USB2- or RS232 Receive	Part of the Motorola Solutions SB9600 communications bus to connect external devices. It is also used for the USB host interface or 5 V RS232_TX. Defaults to BUS-. Idles at 0 V.
4	RS232_TX_9V	RS232 Transmit Data	Part of the 4-wire RS232 interface to the external data accessories, programming cables, and other accessories. An output normally -9 V no load.
5	RS232_RX_9V	RS232 Receive Data	Part of the 4-wire RS232 interface to external data accessories, programming cables, and other accessories.
6	USB-	USB-Data	Part of the 2-wire USB device differential data bus that is used to connect to items such as a programming cable or a modem.
7	USB+	USB+Data	
8	RESET/ USB2_VBUS_H or RS232_RTS_5V	SB9600 RESET or USB2_VBUS_HOST or RS232 Ready to Send	Part of the Motorola Solutions SB9600 communications bus to connect to the external devices. In USB Host mode, this signal is the 5 V VBUS supply to a downstream device. It is also used for the USB host interface or 5v RS232_TX Defaults to RESET.

Pin #	Pin Name		Pin Function
9	BUSY or RS232_CTS_5 V	SB9600 BUSY or RS232 Clear to Send	Part of the Motorola Solutions SB9600 communications bus to connect to the external devices or 5v RS232_CTS. Defaults to BUSY.
10	RS232_RTS_9 V	RS232 Request-To-Send	Part of the 4-wire RS232 interface to external data accessories. An output of normally +9 V no load.
11	RS232_CTS_9 V	RS232 Clear-To-Send	Part of the 4-wire RS232 interface to external data accessories. An input normally at +9 V no load.
12	USB_VBUS_D	USB_VBUS_DEVICE	5 V VBUS input for USB connectivity, supplied by the USB Host such as a programming cable.
13	CHAN ACT	Channel Activity	Active low output used to indicate detection or unsquelching of a qualified received signal (idles at 5 V).
14	GROUND	Ground	Preferred ground for any of the analog lines on J2.
15	EMERGENCY	Emergency	Input used to detect emergency activation. This pin must be connected to the ground by a cable if emergency is disabled. If enabled, this line must be grounded through a switch that is normally closed.
16	AUX PTT	Push-To-Talk	Pulling this line to ground activates PTT function, normally selecting the AUX_MIC input.
17	ONE WIRE	1-Wire® data	0–5 V bidirectional data used for identification of smart accessories or cables. **CAUTION:** An external source of voltage could damage the microprocessor.
18	VIP OUT 1	Vehicular Interface Output	High-voltage open drain output used for enabling relays used for accessories such as horn/lights.
19	VIP OUT 2	Vehicular Interface Output	
20	SPKR+	Speaker +	Used along with SPKR- to connect an external speaker. The audio PA is a bridge amplifier. See Radio Specifications for speaker impedance and loads.
21	RX FILT AUDIO	Receive Filtered Audio Out	Signal is a fixed level (independent of volume level) received audio signal, including alert tones. Flat or de-emphasis is programmed by the CPS. Output voltage is approximately 100 mVrms per 1 kHz of deviation. The DC offset is 1.4 V.
22	MONITOR	Monitor overrides PL	Active low input used to detect when a rear microphone accessory is taken 'off-hook' to over-

Pin #	Pin Name		Pin Function
			ride PL to alert the user to busy traffic before transmitting (idles at 5 V).
23	AUX MIC	Rear microphone input	This microphone signal is independent of the microphone signal on the front microphone connector. The nominal input level is 80 mVrms for 60% deviation when used for motorcycle, but can also support 300 mVrms for future APCO accessories. The DC impedance is 1560 ohms and the AC impedance is 560 ohms, 1 Vrms max. 9 VDC with no input load.
24	SW B+	Switched Battery Voltage	A+ battery voltage is available when the radio is switched on. Used as supply for certain J2 accessories.
25	IGN sense (ACC)	Vehicle Ignition sense (ACC)	Connecting to the ACC line controlled by the vehicle ignition switch that allows CPS ignition features such as “ignition required for turn on” to be used. Connecting this line to the car battery defeats the CPS ignition features.
26	SPKR-	Speaker -	Used with SPKR+ to connect an external speaker. The audio PA is a bridge amplifier. See Radio Specifications for speaker impedance and loads.

9.1.3
J100 CHUC – Mobile Accessory Port Interface for APX 7500

NOTE: Not applicable for O3 control heads.

J100 is located on the back of the control head assemblies in the remote mount configuration. This connector provides pins located identical to connector J2 at the back of a mid power transceiver.

Not all the pins are populated at J100 due to identical functionality on connectors J200, J400, J600, and J700. APCO audio pins can be located at J100. The VIP OUT 1 and VIP OUT 2 function at this connector when no cable is attached at J400. Figure 285: J100 Mobile Accessory Port (MAP) Connector on page 302 illustrates the J100 Mobile Accessory Port (MAP) connector while Table 71: J100 Remote Mount Control Head Mobile Accessory Port (MAP) on page 303 describes the function of each pin.

Figure 285: J100 Mobile Accessory Port (MAP) Connector

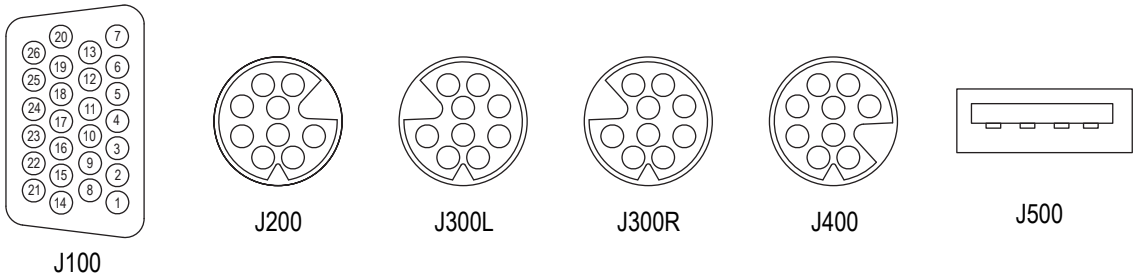


Table 71: J100 Remote Mount Control Head Mobile Accessory Port (MAP)

Pin #	Pin Name		Pin Function
1	GND	Ground	Preferred ground for digital signals.
2	N/C	No Connect	
3	N/C	No Connect	
4	N/C	No Connect	
5	N/C	No Connect	
6	USB-	USB- Data	Part of the USB differential data bus.
7	USB+	USB+ Data	Part of the USB differential data bus.
8	N/C	No Connect	
9	N/C	No Connect	
10	N/C	No Connect	
11	N/C	No Connect	
12	USB_VBUS	USB_VBUS_DEVICE	Used for USB enumeration. 5 V is applied to this pin by a USB HOST accessory.
13	CHAN ACT	Channel Activity [A(p)]	5 V active low output signal used to indicate that a qualified receive signal is present. One second after power-up, this line goes low for 1.8 seconds while the CHIB is configured. Therefore, this line should be ignored for at least 2.8 seconds after power-up. APCO required.
14	GND	Ground	Preferred ground for analog signals.
15	EMERGENCY	Emergency	Input used to detect emergency activation.
16	AUX PTT	AUX PTT [PTT]	Pulling this line to ground will activate PTT function normally selecting the AUX_MIC input. APCO required.
17	ONE WIRE	1-Wire® data	0-2.8 V bidirectional data used for identification of smart accessories/cables.
18	VIP OUT 1	Vehicular Interface Output	High voltage open drain output used for enabling relays used for accessories such as horn/lights.
19	VIP OUT 2	Vehicular Interface Output	High voltage open drain output used for enabling relays used for accessories such as horn/lights.
20	N/C	No Connect	
21	RX FILT AUDIO	Receive Filtered Audio Out [A(rx)]	This is a fixed level (independent of volume control setting) received audio signal, including alert tones. Flat or de-emphasis is programmed by CPS. Output voltage is approximately 100

Pin #	Pin Name		Pin Function
			mVrms per 1 kHz of deviation. The DC offset is 1.4 V. APCO required.
22	MONITOR	Monitor overrides PL	Active low input used to detect when a rear microphone accessory is taken 'off-hook', to over-ride PL to alert the user to busy traffic prior to transmitting (idles at 5 V).
23	AUX MIC	Rear microphone input [A(tx)]	This microphone signal is independent of the microphone signal on the front microphone connector. The nominal input level is 80 mVrms for 60 % deviation when used for motorcycle, but can also support 300 mVrms for future APCO accessories. The DC impedance is 1560 ohms and the AC impedance is 560 ohms, 1 Vrms max. 9 V DC with no input load. APCO required.
24	SW B+	Switched Battery Voltage	A+ battery voltage is available when the radio is switched on. Used as supply for certain J2 accessories.
25	N/C	No Connect	
26	N/C	No Connect	

9.1.4
J200 CHUC – Power and Audio Interface

NOTE: Not applicable for O3 control heads.

J200 is located on the back of control head assemblies in the remote mount configuration. This connector provides the voltage into the transceiver, as well as Ignition sense (ACC) and speaker lines.

An alternate power cable can be used at this connector to provide Earjack audio and TX/RX record out audio. Refer to the installation manual for ordering part numbers. Figure 286: J200 Power and Audio Connector on page 304 illustrates the J200 connector while Table 72: J200 Power and Audio Connector Pin Functions on page 305 describes the function of each pin.

Figure 286: J200 Power and Audio Connector

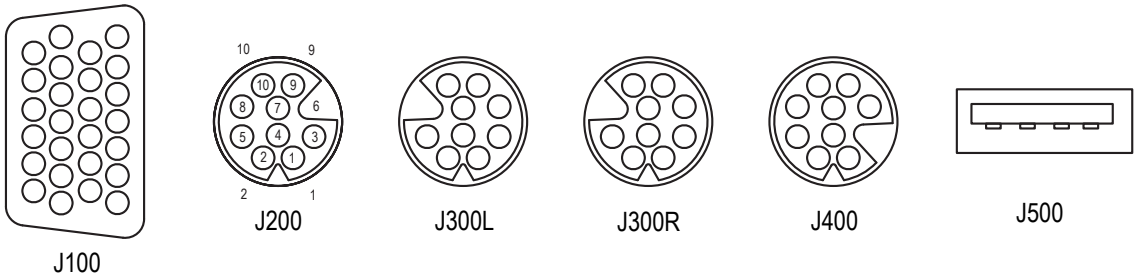


Table 72: J200 Power and Audio Connector Pin Functions

Pin #	Pin Name	Pin Function
1	SPEAKER +	Primary output for external speaker. Refer to Radio Specifications page for speaker impedances and loads.
2	SPEAKER -	Primary output for external speaker. Refer to Radio Specifications page for speaker impedances and loads.
3	Record Out	Dedicated pin at a fixed level of 300 mv
4	GND (analog)	Analog ground used for Record out.
5	Earjack	Dedicated audio path with a fixed level output higher than Record out. Mutes the Audio PA when connected to an earpiece (an external speaker attached at J200 mutes upon attachment of earpiece).
6	NO PIN	
7	C.H. SPEAKER MUTE	For Headset MUTING...by turning-off audio PA in C.H. This does not MUTE the radio rear speaker.
8	GND for Pwr	Shared for POWER and audio grounds
9	IGN Sense (ACC)	Sense line to determine the state of the vehicle IGNITION.
10	A+ (cable FUSED)	Control Head power supply.

9.1.5
J300 CHUC – Controller Area Network (CAN) Interface

NOTE: Not applicable for O3 control head.

J300L and J300R are located on the back of the control head assemblies in the remote mount configuration. These two connectors are identical, in order to aid in future daisy-chaining of other CAN bus accessories.

They provide the Data, digital audio, and power on/off/reset commands for the control head to transceiver communications. Refer to the installation manual for ordering part numbers for various lengths of the CAN remote mount cables. Figure 287: J300 Controller Area Network (CAN) Connector on CHIB on page 305 illustrates the J300 connector while Table 73: J300 Controller Area Network Connector Pin Functions on page 306 describes the function of each pin.

Figure 287: J300 Controller Area Network (CAN) Connector on CHIB

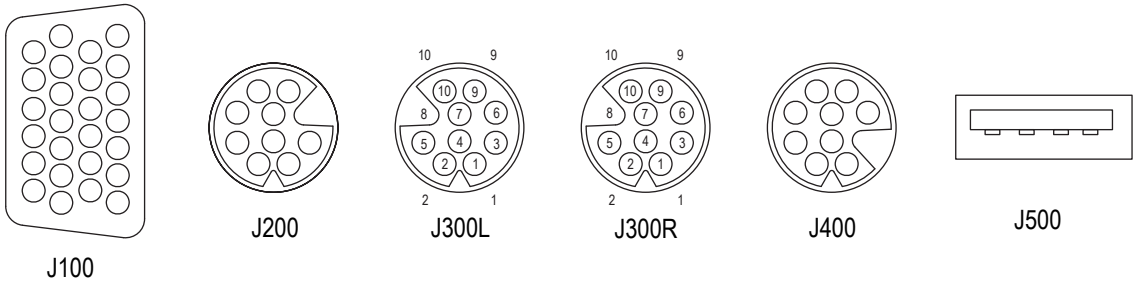


Table 73: J300 Controller Area Network Connector Pin Functions

Pin #	Pin Name	Pin Function
1	CAN_1_HIGH	TX+ (AUDIO)
2	CAN_1_LOW	TX- (AUDIO)
3	CAN_3_HIGH	TX+ (PWR) Dedicated for System ON/OFF/RE-SET commands.
4	CAN termination detect pin	Pin 4 shorted to GND inside each end of the CAN cable.
5	A+	Only routed on the “03” CAN cable
6	CAN_3_LOW	TX- (PWR) Dedicated for System ON/OFF/RE-SET commands.
7	GND	Drain wire wrapped around GND shield
8	NO PIN	
9	CAN_2_HIGH	TX+ (DATA)
10	CAN_2_LOW	TX- (DATA)

9.1.6
J400 CHUC – VIP and DEK Interface

NOTE: Not applicable for O3 and E5 control heads.

J400 is located on the back of the control head assemblies in the remote mount configuration. This connector provides the ability to utilize up to 3 VIP OUT, 3 VIP IN, the GND and SWB+ pins they require, or DEK signal lines.

This connector has cable detection pins to allow the control head to determine which type of cable is being used, and therefore allow the control head to configure its pins appropriately for either VIP or DEK accessory interfacing. It is not recommend to fabricate this cable from scratch. The cable must be inserted prior to control head power-up. Refer to the installation manual for ordering part numbers for either the VIP or DEK cable. Figure 288: J400 VIP and DEK Connector on page 306 illustrates the J400 connector while Table 74: J400 VIP and DEK Connector Functionality on page 306 describes the function of each pin.

Figure 288: J400 VIP and DEK Connector

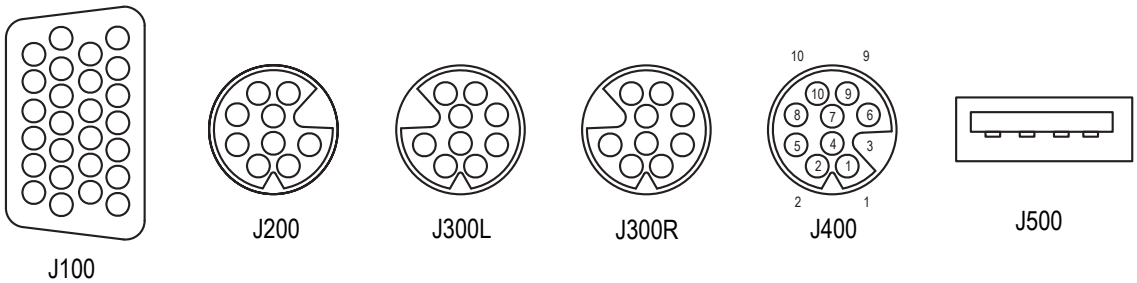


Table 74: J400 VIP and DEK Connector Functionality

Pin #	No cable	DEK cable	VIP cable	Future cable	Future cable
1	SWB+	SWB+	SWB+	SWB+	SWB+

Pin #	No cable	DEK cable	VIP cable	Future cable	Future cable
2	GND	GND	GND	GND	GND
3	no pin	no pin	no pin	no pin	no pin
4	Detect Pin 1 (Short to GND)	Detect Pin 1 (Short to GND)	Detect Pin 1 (Short to SWB+)	Detect Pin 1 (Short to GND)	Detect Pin 1 (Short to GND)
5	no pin	STROBE	VIP_OUT_1	no pin	no pin
6	no pin	DATA-OUT	VIP_OUT_2	no pin	no pin
7	no pin	CLOCK	VIP_OUT_3	no pin	no pin
8	Detect Pin 2 (Short to GND)	Detect Pin 2 (Short to SWB+)	VIP_IN_1	Detect Pin 2 (Short to GND)	Detect Pin 2 (Short to SWB+)
9	Detect Pin 3 (Short to GND)	Detect Pin 3 (Short to GND)	VIP_IN_2	Detect Pin 3 (Short to SWB+)	Detect Pin 3 (Short to SWB+)
10	no pin	DATA-IN	VIP_IN_3	no pin	no pin

9.1.7

J500 CHIB – USB HOST Interface

NOTE: Not applicable for CHIB used for E5 Control Heads. In the E5 CHIB, USB Host function is integrated in J100 Connector.

The USB host series "A" Receptacle interface interacts with USB devices through the Host Controller. It is located at the back of the CHIB.

This connector supports low and full speed devices that complies with USB 2.0 standard included in the Motorola Solutions approved list.

Figure 289: J500 USB Host Connector

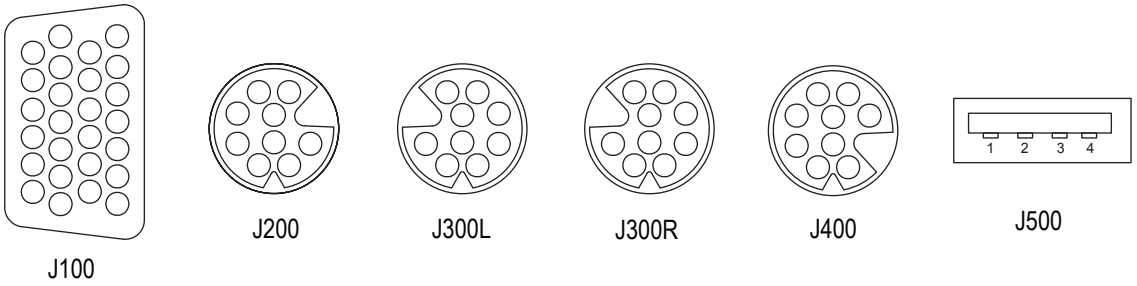


Table 75: J500 USB Host Connector

Pin #	Pin Name	Pin Color	Pin Function
1	VBUS_Host	Black	Host supplied Power to accessory
2	Data (-)	Red	Data signal
3	Data (+)	Yellow	Data signal
4	GND	Green	Bus GND return

9.1.8

J600 TIB – Data and Audio Interface

The J600 is on the Transceiver Interface Board (TIB). This connector is the legacy accessory interface, but contains some additional pin functionality.

Figure 290: J600 Connector on page 308 and Table 76: J600 Remote Mount Accessory Connector on page 308 illustrate and describe the connector and the function of each pin.

Figure 290: J600 Connector

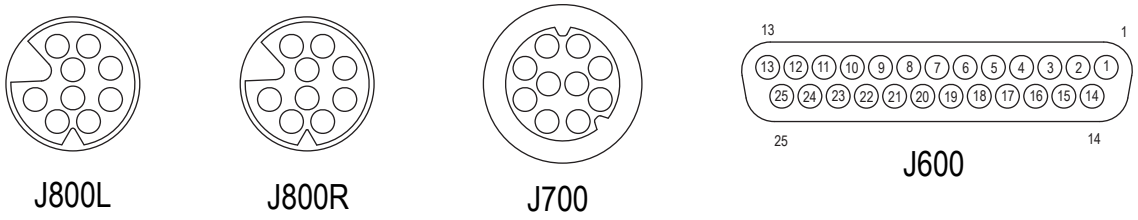


Table 76: J600 Remote Mount Accessory Connector

Pin #	Pin Name		Pin Function
1	AUX_PTT	Auxiliary PTT input	Pulling this line to ground activates the PTT function normally selecting AUX_MIC input. Jumpers exist on the TIB to change this pin to Ignition sense (ACC) or VIP_IN 1 at 3.3 V levels.
2	RS232_TXD_9V	RS232 Transmit Data	Part of the 4-wire RS232 interface to external data accessories, programming cables, and others. An output normally -9 V no load. A jumper exists on the TIB to change this pin to shield connection.
3	RS232_RXD_9V	RS232 Receive Data	Part of the 4-wire RS232 interface to external data accessories, programming cables, and others. A jumper exists on the TIB to change this pin to REMOTE IGNITION.
4	RS232_CTS_9V	RS232 Clear-To-Send	Part of the 4-wire RS232 interface to external data accessories, programming cables, and others. Jumpers exist on the TIB to change this pin to AUX_MIC, MIC_IN, or VIPOUT_1 (passthrough). MIC_IN routes to the transceiver MIC_HI input.
5	BUS+/ RS232_TXD_5V	SB9600 BUS+/ RS232 Transmit	Part of the Motorola Solutions SB9600 communications bus to connect external devices. RS232 is made available instead of SB9600 with a Motorola Solutions "RS232-activation" cable, without the need to remove any jumpers on the TIB.
6	RX_AUDIO	Receive Filtered Audio Out	This is a fixed level (independent of volume level) received audio signal, including alert tones. Flat or de-emphasis is programmed by the CPS. Output voltage is approximately 100 mVrms per 1 kHz of deviation. The DC offset is 1.4 V. Formerly called RX_Filtered_Audio.

Pin #	Pin Name		Pin Function
7	AUX_RX		Formerly called RX_Audio. This pin is an input to the radio. This input is routed through the volume control circuitry to the speaker. Nominal input level is 300 mVrms.
8	AUX_TX		Formerly called TX_audio. This pin is an input to the radio. This input is routed to the transmitter through multiplexed lines that are controlled by the microprocessor. Nominal input level is 300 mVrms.
9	RX_AUDIO		This pin is the same as pin 6. A jumper exists to change this pin to VIP_IN 2 at 3.3 V levels.
10	GND	Ground	N/A
11	GND		
12	DAC_AUDIO_OUT & AUX_MIC		Audio spoken from the operator is OUTPUT from the radio. When the radio detects the SB9600 PTT command, this pin switches into an audio INPUT line (during PTT) and is routed into the AUX_MIC path of the radio. AUX_PTT does not turn this pin into an INPUT pin. Jumpers exist on the TIB to change this pin to AUX_MIC or MIC_IN (MIC_IN=MIC_HI inside radio).
13	EMERGENCY	Emergency	Input used to detect emergency activation. To use this input, remove the shorting jumper on the TIB that grounds this input. After the jumper is removed, emergency operation is possible at either this connector or at the J2 connector.
14	BUS-/ RS232_RXD_5V	SB9600 BUS- / RS232 Receive	Part of the Motorola Solutions SB9600 communications bus to connect external devices. RS232 is made available instead of SB9600 with a Motorola Solutions “RS232-activation” cable, without the need to remove any jumpers on the TIB. Idles at 0 V.
15	AUX_MIC	Auxiliary microphone input	VIPOUT_1 as the default state of this pin. The nominal input level for AUX_MIC is 80 mVrms for 60% deviation when used for motorcycle, but can also support 300 mVrms for future APCO accessories. The DC impedance is 1560 ohms and the AC impedance is 560 ohms, 1 Vrms max 9 VDC with no input load. Jumpers exist on the TIB to change this pin to AUX_MIC, MIC_IN, DAC_AUDIO_OUT, and VIPOUT_1 (passthrough). MIC_IN routes to the transceiver MIC_HI input.
	VIPOUT_1	Vehicle Interface Port 1	
16	REMOTE IGNITION	Front Ignition sense (ACC) which is independent of the Rear Ignition	Connecting to the ACC line controlled by the ignition switch of the vehicle allows CPS ignition features such as “ignition required for turn on” to be used. Connecting this line to the car battery defeats the CPS ignition features.

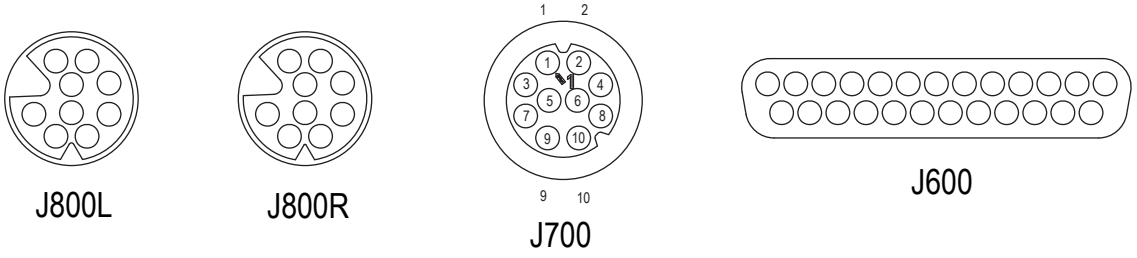
Pin #	Pin Name		Pin Function
		sense (ACC) at the J2 connector	
17	RS232_RTS_9V	RS232 Request to Send	Part of the 4-wire RS232 interface to external data accessories, programming cables, and others. An output normally +9 V no load. A jumper exists on the TIB to change this pin to VIPOUT_2 (passthrough).
18	GND	Ground	N/A
19	RESET/ RS232_RTS_5v	SB9600 RESET/RS232 Ready to Send	Part of the Motorola Solutions SB9600 communications bus to connect external devices. RS232 is made available instead of SB9600 with a Motorola Solutions “RS232-activation” cable, without the need to remove any jumpers on the TIB.
20	A+	Battery Voltage	N/A
21	GND	Ground	N/A
22	SWB+	Switched Battery Voltage	This voltage is available when the radio is switched on.
23	BUSY/ RS232_CTS_5V	SB9600 BUSY/ RS232 Clear to Send	Part of the Motorola Solutions SB9600 communications bus to connect external devices. RS232 is made available instead of SB9600 with a Motorola Solutions “RS232-activation” cable, without the need to remove any jumpers on the TIB.
24	SPKR-	Speaker-	Used along with SPKR+ to connect an external speaker. The audio PA is a bridge amplifier. Refer to the Radio Specifications page for speaker impedances and loads.
25	SPKR+	Speaker+	Used along with SPKR- to connect an external speaker. The audio PA is a bridge amplifier. Refer to the Radio Specifications page for speaker impedances and loads.

9.1.9
J700 TIB – Mobile Microphone Port (MMP)

J700 is located on the transceiver interface board (TIB) used in the remote mount configuration. This connector is the MMP connector.

NOTE: The same TIB is used for both mid power and high power transceivers. Figure 291: J700 MMP Programming Connector on page 311 illustrates the J700 connector while Table 69: MMP Connector Signal Descriptions on page 299 describes the function of each pin.

Figure 291: J700 MMP Programming Connector



9.1.10

J800 TIB – Controller Area Network (CAN) Interface

J800L and J800R are located on the transceiver interface board (TIB). These two connectors are identical, in order to aid in future daisy-chaining of other CAN bus accessories.

They provide the Data, digital audio, and power on/off/reset commands for the control head to transceiver communications. Please refer to the installation manual for ordering part numbers for various lengths of the CAN remote mount cables. Figure 292: J800 Controller Area Network (CAN) Connector on TIB on page 311 illustrates the J800 connector while Table 77: J800 Controller Area Network Connector Pin Functions on page 311 describes the function of each pin.

Figure 292: J800 Controller Area Network (CAN) Connector on TIB

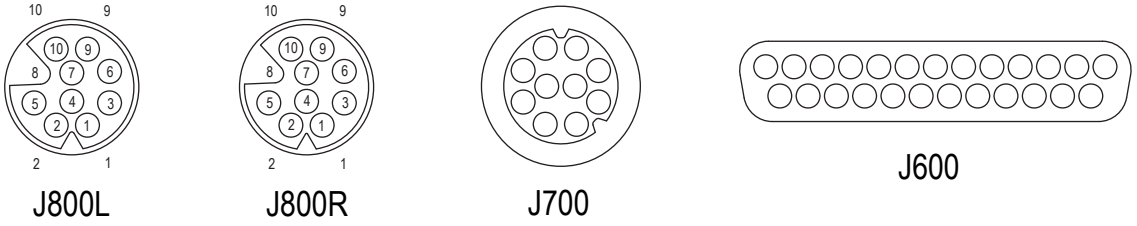


Table 77: J800 Controller Area Network Connector Pin Functions

Pin #	Pin Name	Pin Function
1	CAN_1_HIGH	TX+ (AUDIO)
2	CAN_1_LOW	TX- (AUDIO)
3	CAN_3_HIGH	TX+ (PWR) Dedicated for System ON/OFF/ RESET commands.
4	CAN termination detect pin	Pin 4 shorted to GND inside each end of the CAN cable.
5	A+	Only routed on the “03” CAN cable
6	CAN_3_LOW	TX- (PWR) Dedicated for System ON/OFF/RE-SET commands.
7	GND	Drain wire wrapped around GND shield
8	NO PIN	
9	CAN_2_HIGH	TX+ (DATA)
10	CAN_2_LOW	TX- (DATA)

9.1.11
I/O Disclaimer

Some of the signal lines on the J2 accessory connector are limited to between 0 and 5 V operation while other inputs are limited to between 0 and 20 V. The exception is four-wire RS232, which can tolerate up to ±15 V maximum. At no time should any two (or more) outputs be connected together. Exceeding the input voltages or output loads listed in the above tables could result in electronic component failure. In most cases Zener diodes have been added to protect against ESD.

9.2
Microphone Bias

A 9 V DC microphone bias is present on the MIC_IN line. When this line is loaded by the microphone electronics, as when the PTT button is pressed, the bias voltage drops to between 3 and 6 V. The MIC_IN line has an AC input impedance of 560 ohms. The MIC_IN line should not be loaded such that the bias voltage drops below 1 V or rises above 10.5 V. If the bias voltage falls outside this range, the signal will be clipped by clamping diodes designed to protect the input. When testing with a signal generator or other audio source, use a DC blocking capacitor of 10µF on the MIC_IN line. If the capacitor is polarized, then the plus lead goes to the radio MIC_IN line. If the signal generator has the option of a DC offset, then applying a DC offset of 2.5 V may be used instead of the capacitor. MIC_IN refers to both MIC_HI and AUX_MIC.

9.3
Audio PA Out Bias

The audio PA is a BTL (bridge-to-load) amplifier. When the radio is in receiver mode, the output of both speaker leads bias up to half of the supply voltage. Considering that both leads are at the same potential, the average DC voltage across the load is zero. At maximum volume the signal voltage to the load is double that of one amplifier peak-to-peak because the amplifiers work together 180 degrees out of phase. Caution must be taken not to short either lead to ground, which might cause component damage. Even though audio may still be heard from the speaker, the shorted side will go into current limiting and eventually into thermal shutdown, shutting off the amplifier. These protection devices are not intended to be tested.

9.4
Controller Troubleshooting

Table 78: Controller Troubleshooting Chart on page 312 can help you troubleshoot problems that might occur in the controller section of your radio.

Table 78: Controller Troubleshooting Chart

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
Current too low when A+ applied to radio	Emergency mode may be activated.	In dash-mount, the rear accessory cable with a jumper grounding emergency or an emergency foot-petal must be present. In remote mount, the Transceiver Interface Board (TIB) has a jumper to GND that must be present, or, an emergency foot-petal must be attached to the transceiver or TIB. Attach the necessary cable, accessory, or resistor jumper to prevent accidental emergency mode activation. Verify the signal is low at TIB J600-13 or rear accessory J2-15.

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
	Controller board may be damaged.	Verify output voltage on all regulators.
No audio	Incorrect speaker installation.	Refer to *Installation Manual*. Verify speaker not damaged using a continuity check.
Control head display says Maintenance Mode and draws less than 200 mA	Remote mount Controller Area Network (CAN) cable attached may be disconnected.	Verify all cables securely attached, including power to the radio transceiver.
	Flexes inside radio or control head may be loose.	Open Control Head and check if flexes are not securely attached.
	Is 5 A surface-mount fuse blown inside transceiver?	Continuity test the fuse F401 after disassembling radio. If damaged, replace. Can be blown by accidentally shorting SWB+ to GND.
Radio resets when PTT	Vehicle battery voltage too low to allow radio to transmit.	Try radio on bench with power tuned down, and power supply rated to at least 20 A. Try new vehicle battery.
Radio does not retain secure key when A+ removed for more than 5 minutes	Radio is missing the 3-day secure option board MHLN6999_S, option board is incorrectly installed, or key-retention capacitor is damaged.	Repair/replace/install option board inside radio.
No power on VBUS line to power USB accessory	Incorrect installation of USB accessory on the radio.	Connect USB accessory to “USB Host” pins, not “USB Device” pins. Refer to *Installation Manual* or *Basic Service Manual* chapter listing pin descriptions for each connector. Accessory may not be an approved USB accessory for this radio.
	USB accessory requires more current than the port can supply.	A USB accessory requiring 500 mA can only be attached at the front of the control head Mobile Microphone Port (MMP) port, or the TIB MMP port. The rear accessory connector on the control head or rear of the midpower transceiver can only supply 100 mA.
Radio won’t turn on	Incorrect codeplug setting for vehicle Ignition sense (ACC).	Reprogram the radio using CPS and refer to Help section on possible Ignition settings and their functions. Verify that the Ignition sense (ACC) wire is attached at either the control head or the radio transceiver.
Radio seems too hot	Excessively long transmit times or radio has been constantly transmitting due to a PTT that is jammed.	Replace microphone or foot PTT switch.
	Radio transceiver Installation is located in	Refer to the *Installation Manual*.

Symptom	Possible Cause	Correction or Test (Measurements Taken at Room Temperature)
	a poorly ventilated location.	
	You may have foreign debris inside the radio. Open and inspect.	Clean radio. Look for damaged parts.
Radio not working	Installation could affect radio performance.	Refer to the *Installation Manual* chapter containing recommendations and common radio system problems and solutions.

Chapter 10

Functional Block Diagrams and Connectors

This chapter contains the APX Mobile Radio functional block diagrams and connector locations.

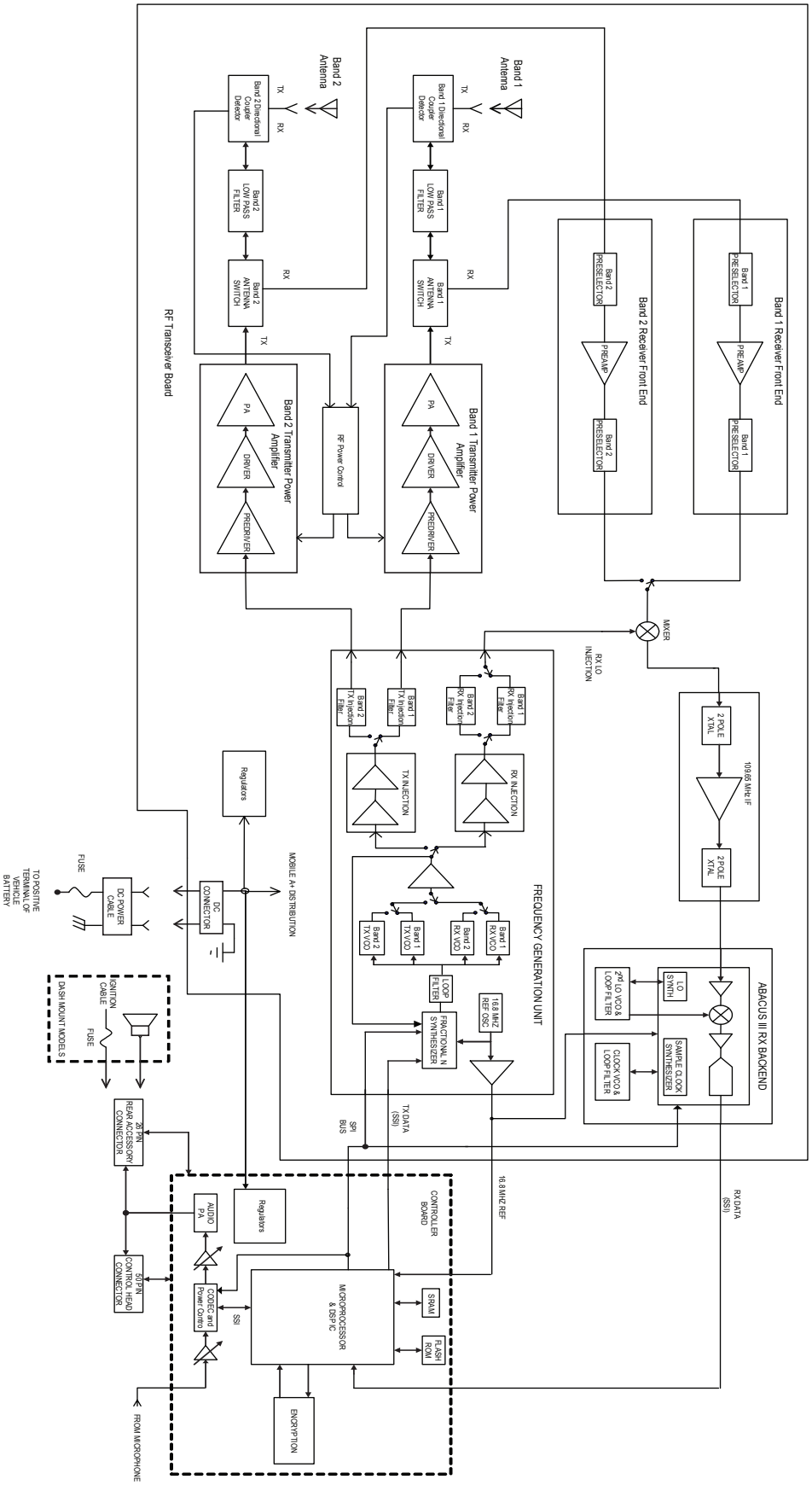
Table 79: Table of Functional Block Diagrams and Connectors

Figure/Page
Figure 293: APX Mobile Radio Transceiver Functional Block Diagram on page 316
Figure 294: O3 Dash and Remote Control Head Functional Block Diagram on page 317
Figure 295: O2, O5, and O7 Dash and Remote Control Head Functional Block Diagram on page 318
Figure 297: O9 Remote Control Head Functional Block Diagram on page 320
Figure 298: O2 Control Head Functional Block Diagram on page 321
Figure 299: O3 Control Head Functional Block Diagram on page 322
Figure 300: O5 Control Head Functional Block Diagram on page 323
Figure 301: O7 Control Head Functional Block Diagram on page 324
Figure 302: O9 Control Head Functional Block Diagram on page 325
Figure 303: O5 Control Head Interface Board (CHIB) Functional Block Diagram on page 326
Figure 304: O2 and O7 Control Head Interface Board (CHIB) Functional Block Diagram on page 327
Figure 306: APX Mobile Radio Transceiver Interface Board (TIB) Functional Block Diagram on page 329
Figure 308: O3 Dash-Mount Radio Connector Locations (Mid Power Only) on page 331
Figure 309: O3 Remote-Mount Radio Connector Locations on page 332
Figure 310: O3 Remote-Mount Radio Connector Locations (High Power Only) on page 333
Figure 311: O5 Dash-Mount Radio Connector Locations (Mid Power Only) on page 334
Figure 312: O5 Remote-Mount Radio Connector Locations (Mid Power Only) on page 335
Figure 313: O5 Remote-Mount Radio Connector Locations (High Power Only) on page 335
Figure 317: Transceiver Interface Board (TIB), Universal Relay Controller & Control Head View. on page 337
Figure 318: Remote-Mount Configuration with 100 W or Higher Power Radio on page 338

10.1

APX Mobile Radio Transceiver Functional Block Diagram

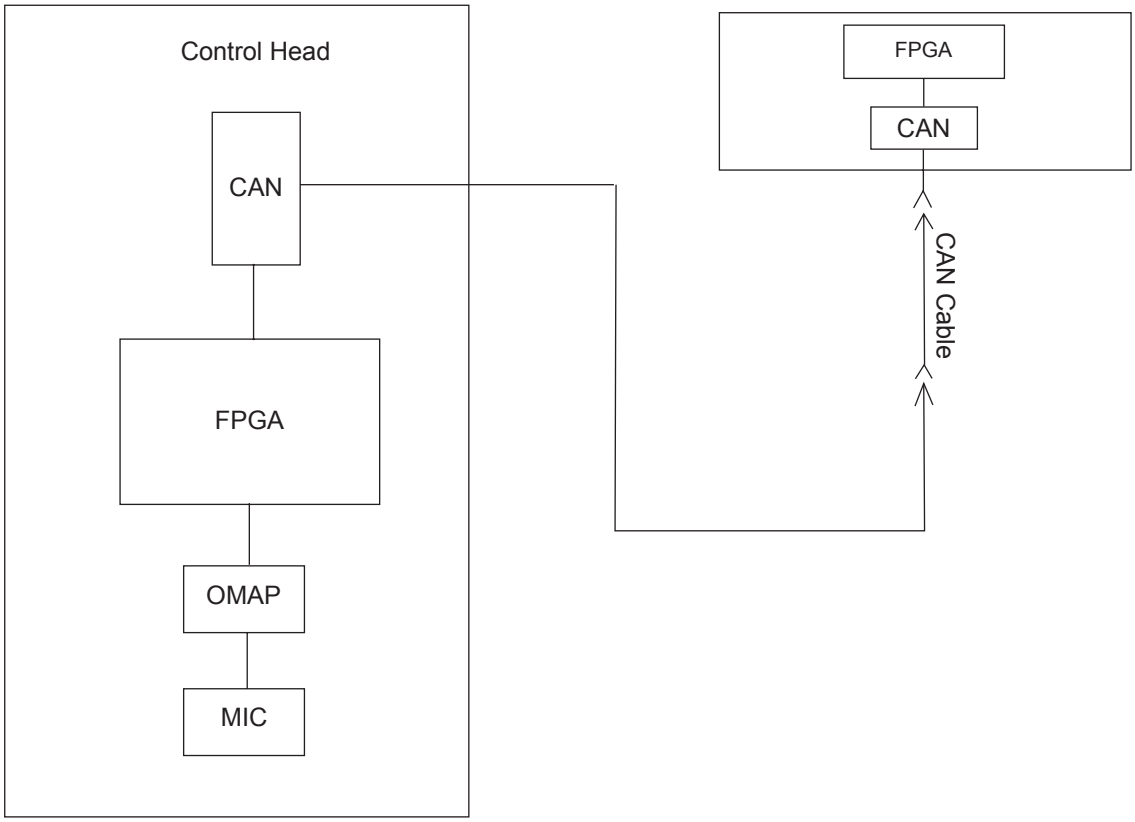
Figure 293: APX Mobile Radio Transceiver Functional Block Diagram



10.2

O3 Dash and Remote Control Head Functional Block Diagram

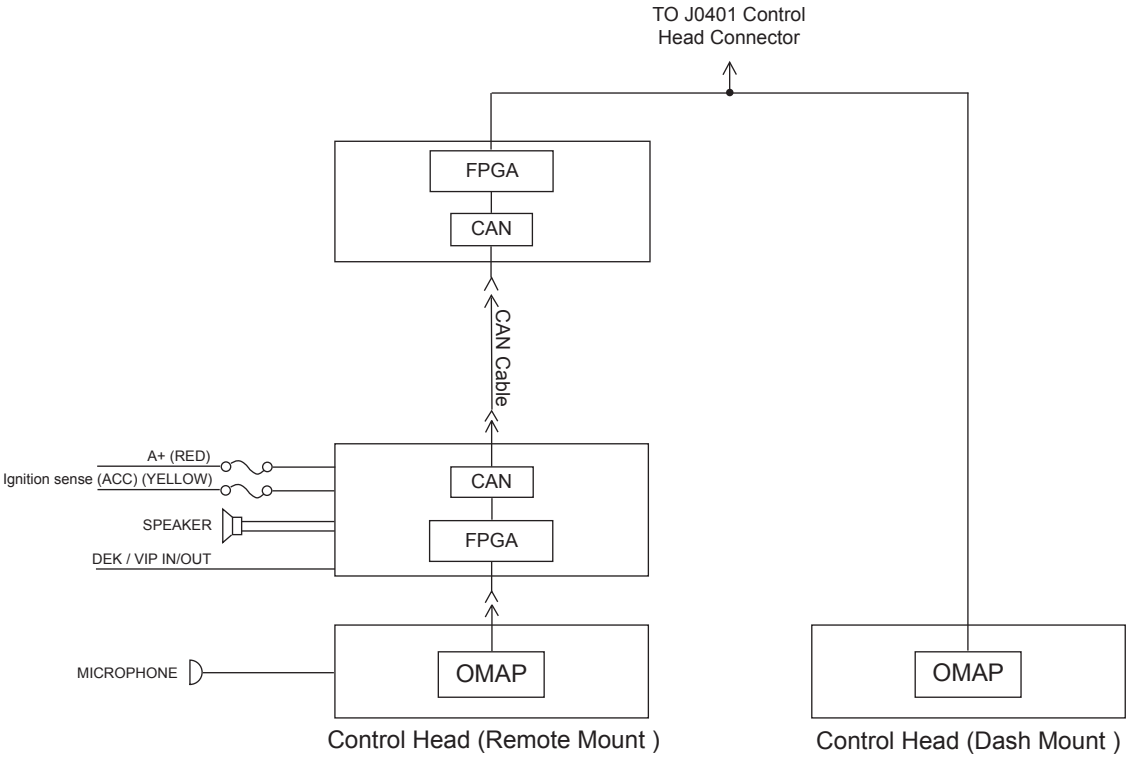
Figure 294: O3 Dash and Remote Control Head Functional Block Diagram



10.3

O2, O5, and O7 Dash and Remote Control Head Functional Block Diagram

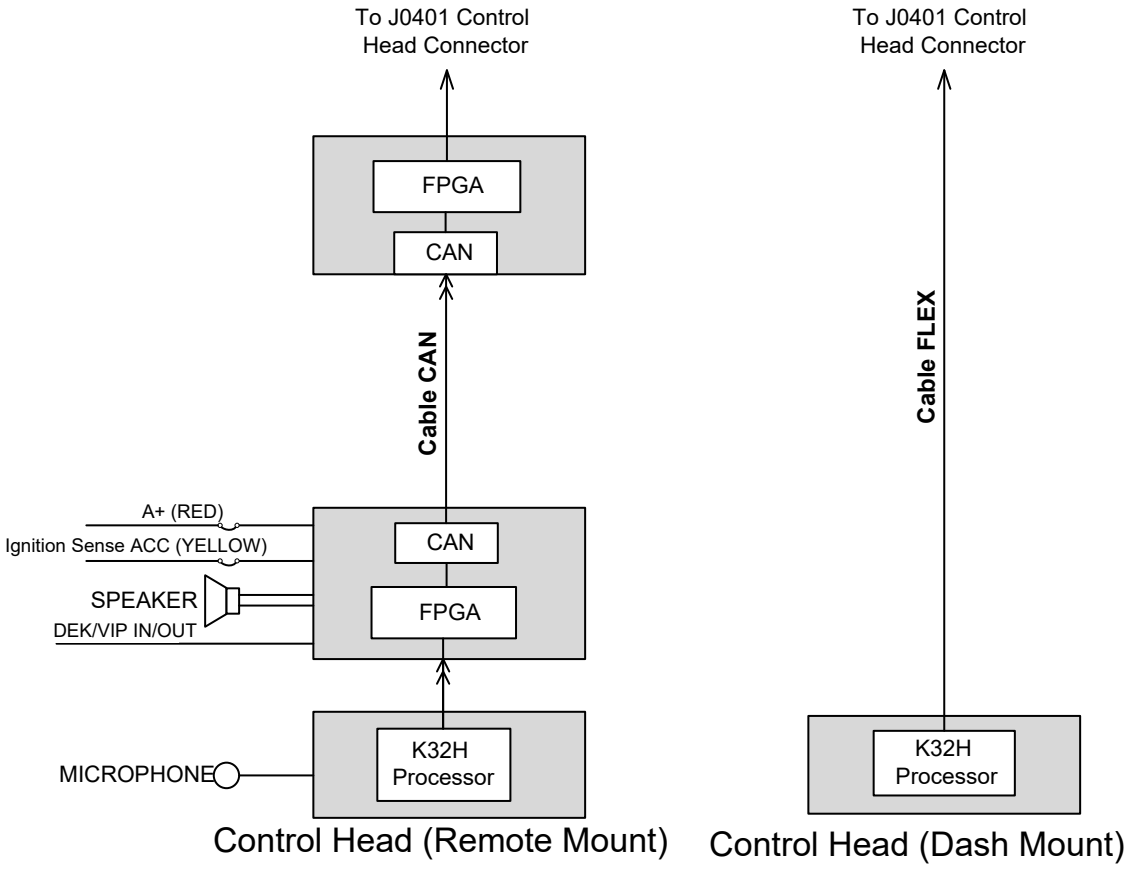
Figure 295: O2, O5, and O7 Dash and Remote Control Head Functional Block Diagram



10.4

E5 Dash and Remote Control Head Functional Block Diagram

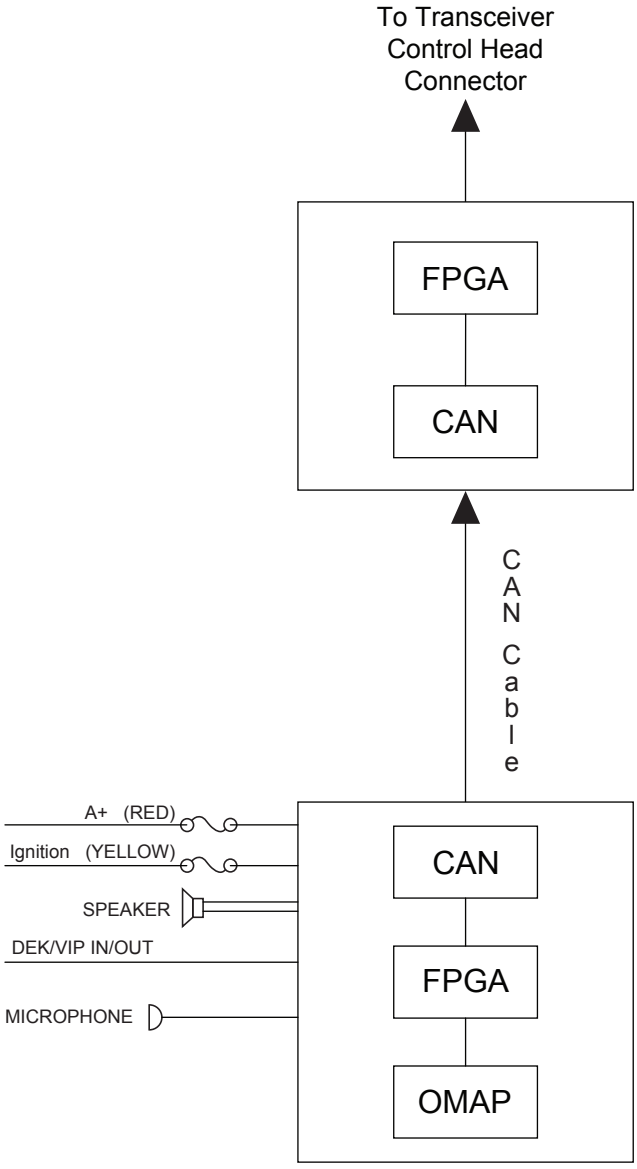
Figure 296: E5 Dash and Remote Control Head Functional Block Diagram



10.5

O9 Remote Control Head Functional Block Diagram

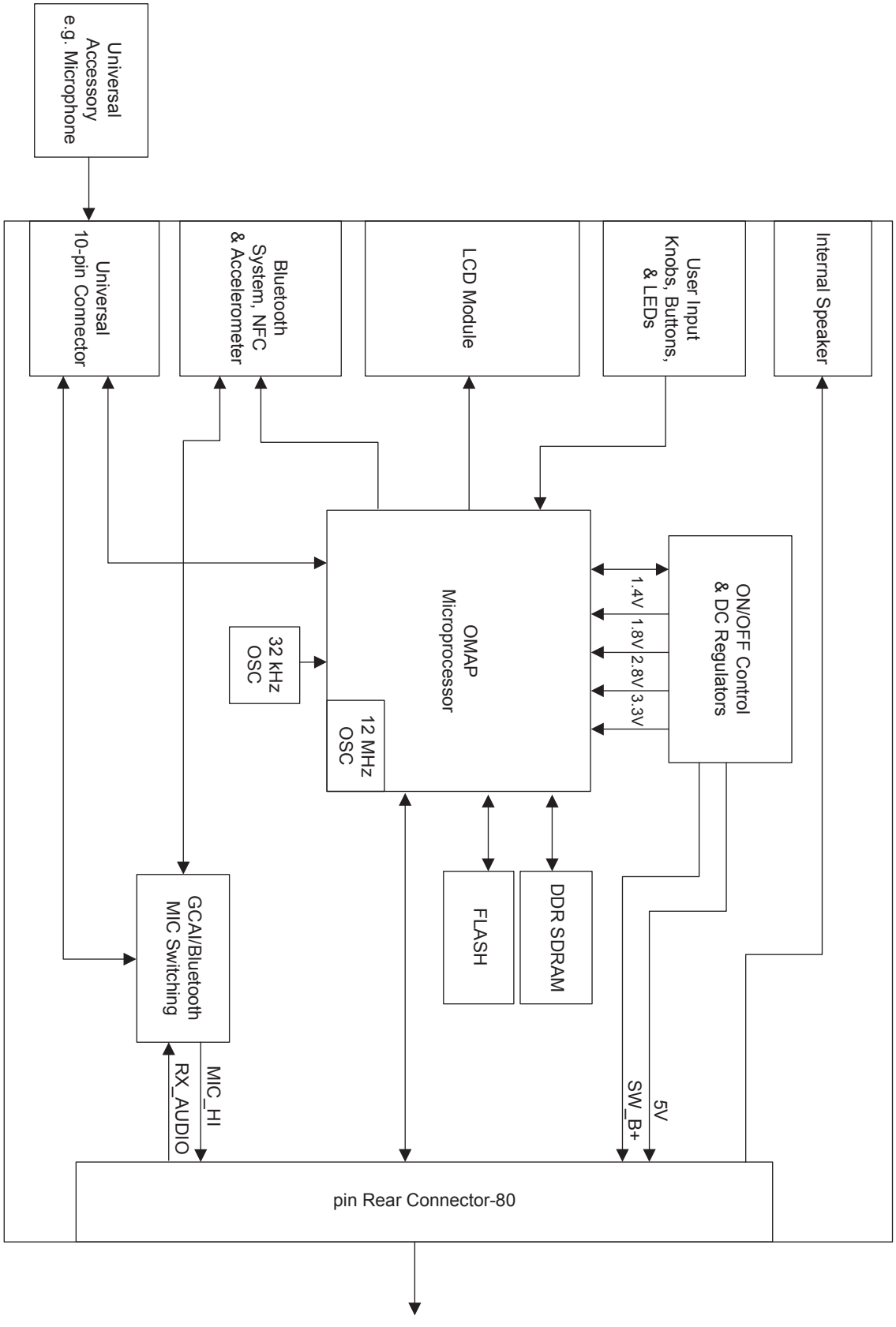
Figure 297: O9 Remote Control Head Functional Block Diagram



10.6

O2 Control Head Functional Block Diagram

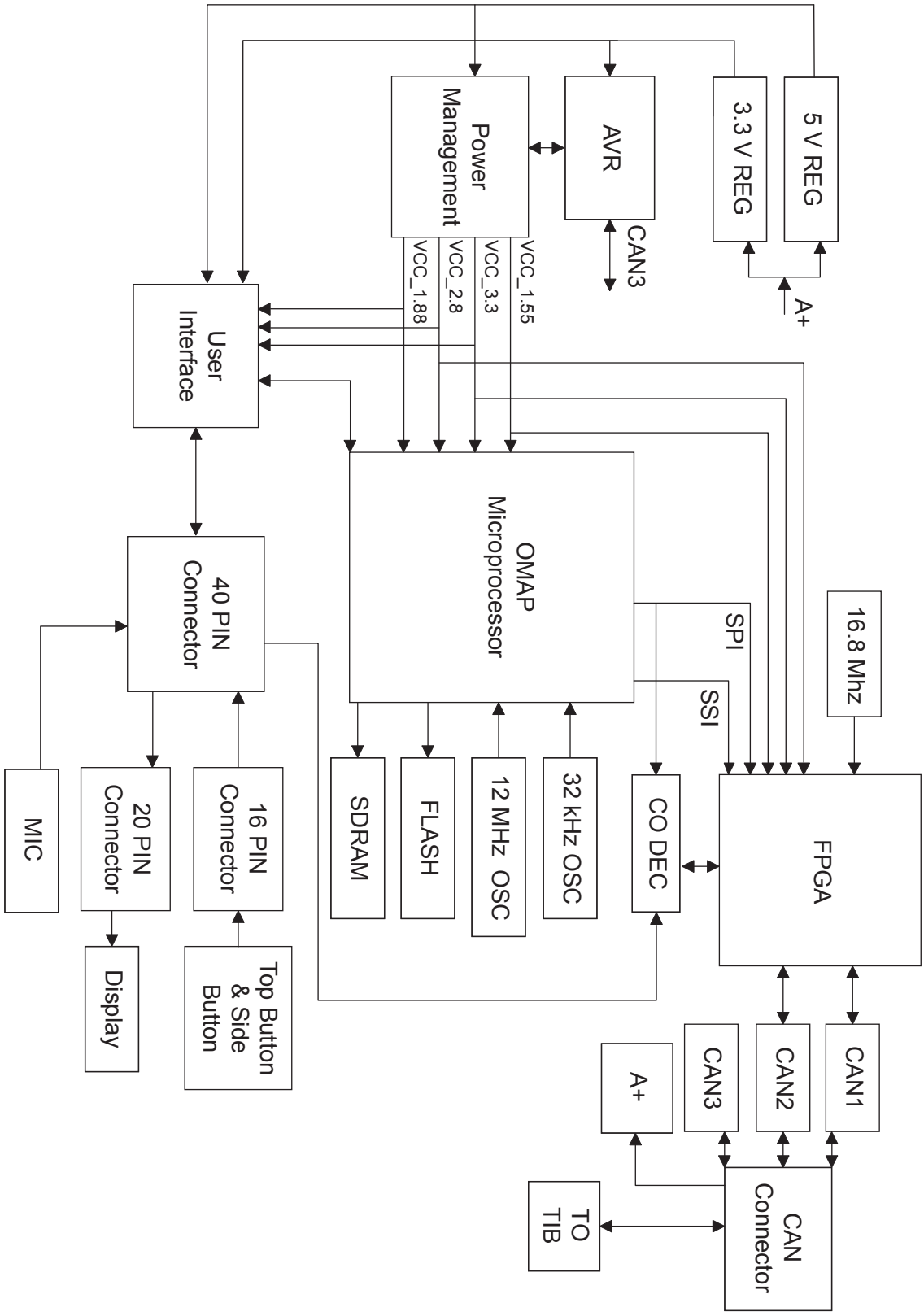
Figure 298: O2 Control Head Functional Block Diagram



10.7

O3 Control Head Functional Block Diagram

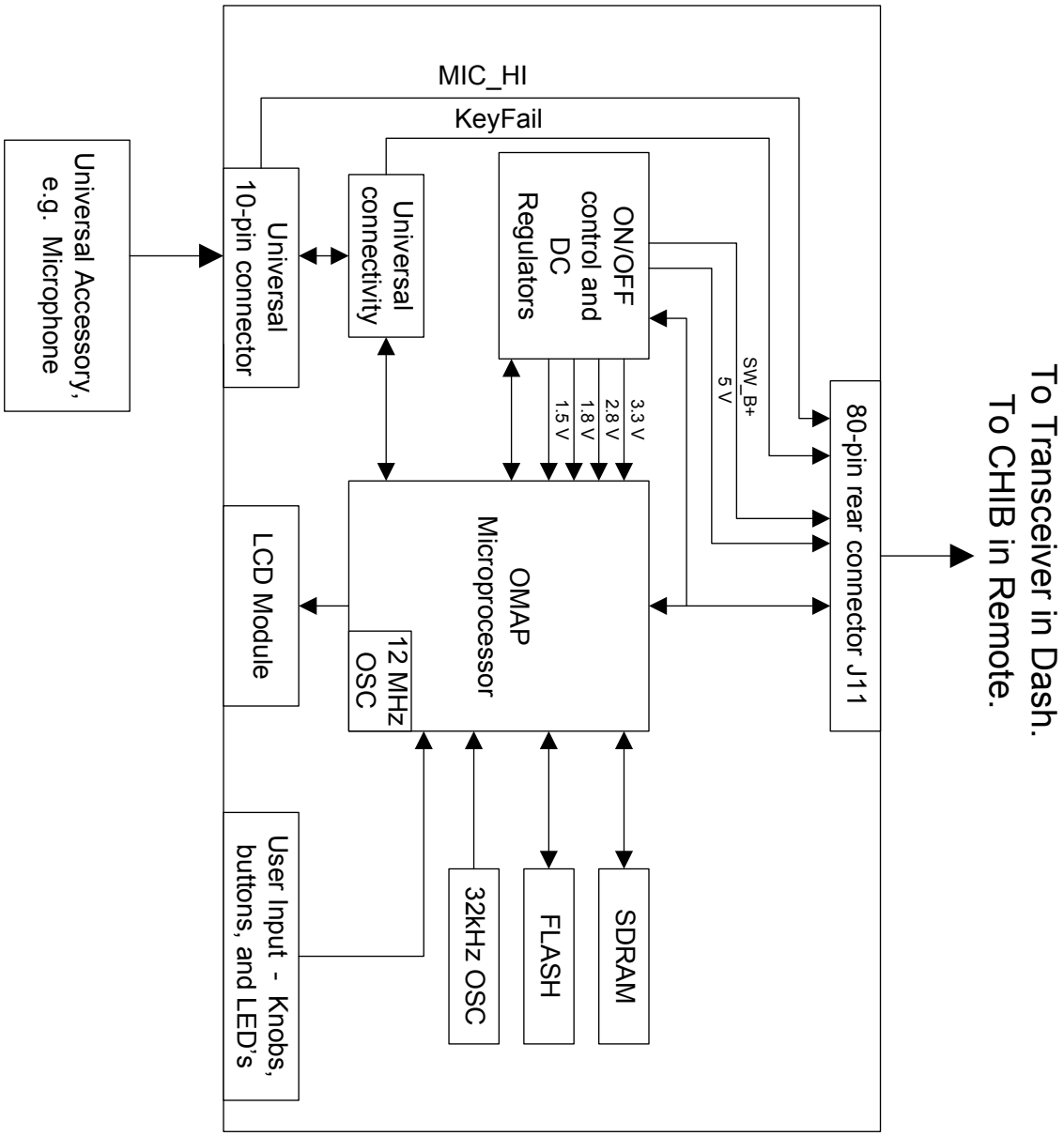
Figure 299: O3 Control Head Functional Block Diagram



10.8

O5 Control Head Functional Block Diagram

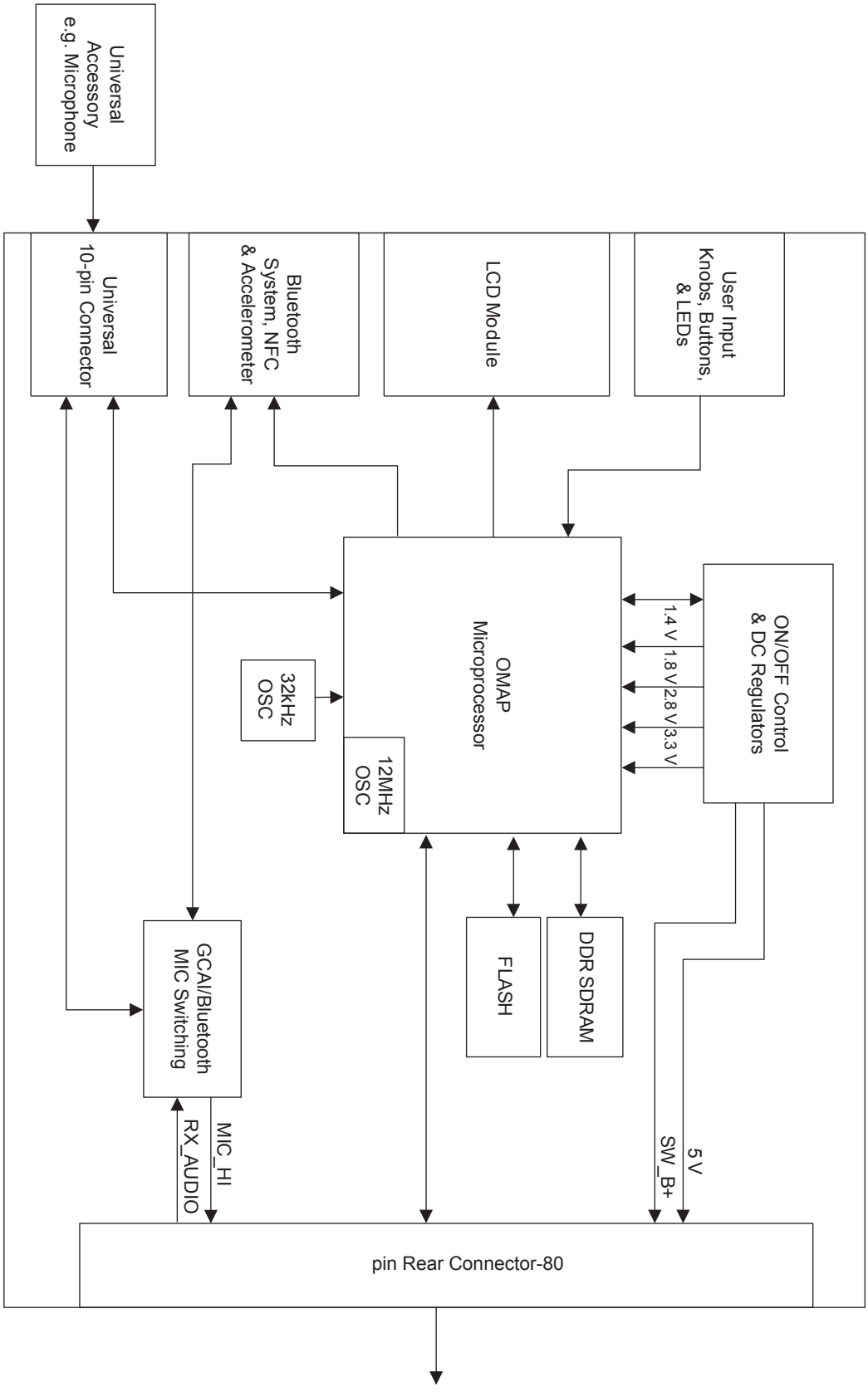
Figure 300: O5 Control Head Functional Block Diagram



10.9

O7 Control Head Functional Block Diagram

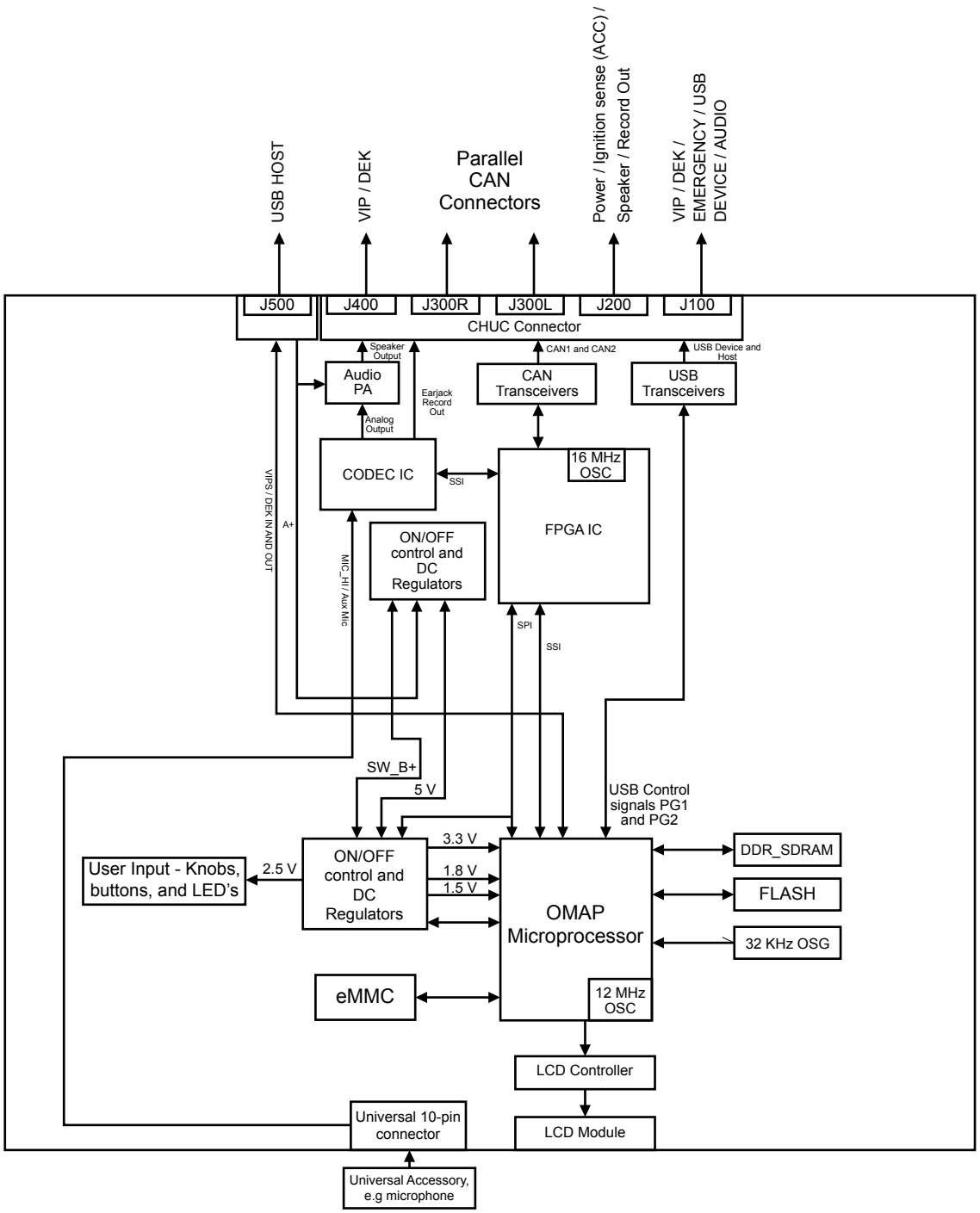
Figure 301: O7 Control Head Functional Block Diagram



10.10

O9 Control Head Functional Block Diagram

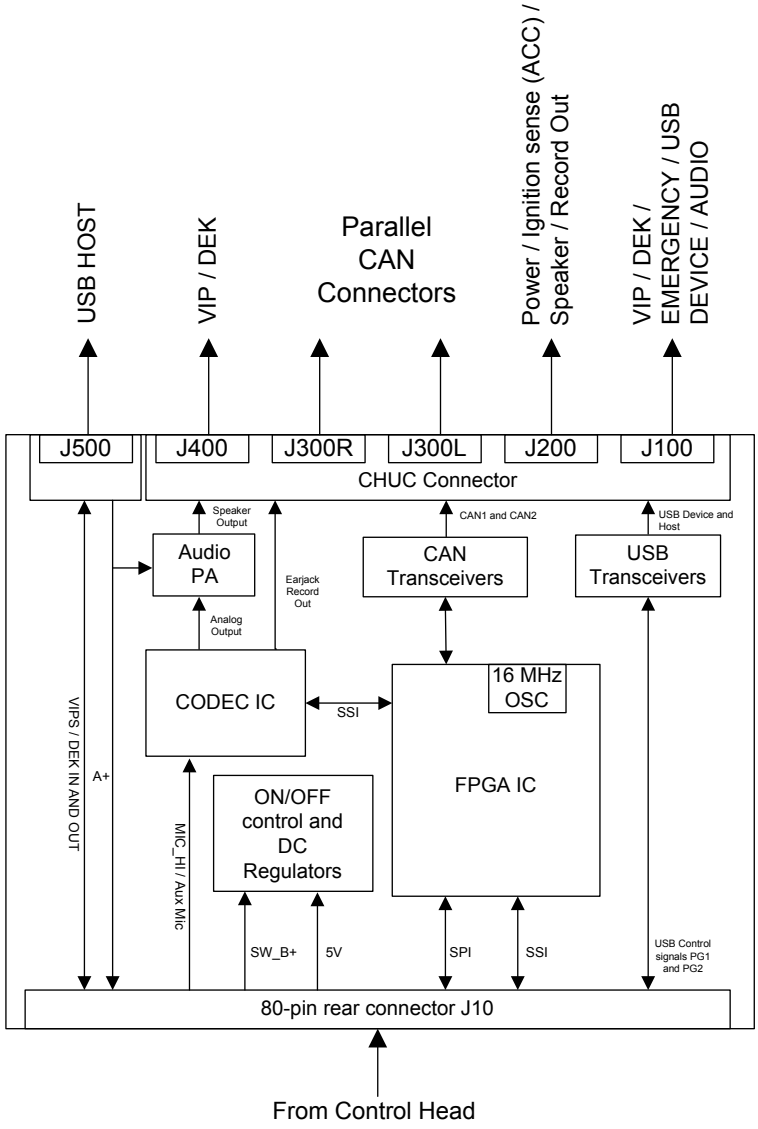
Figure 302: O9 Control Head Functional Block Diagram



10.11

O5 Control Head Interface Board (CHIB) Functional Block Diagram

Figure 303: O5 Control Head Interface Board (CHIB) Functional Block Diagram



10.12

O2, O7, and E5 Control Head Interface Board (CHIB) Functional Block Diagram

Figure 304: O2 and O7 Control Head Interface Board (CHIB) Functional Block Diagram

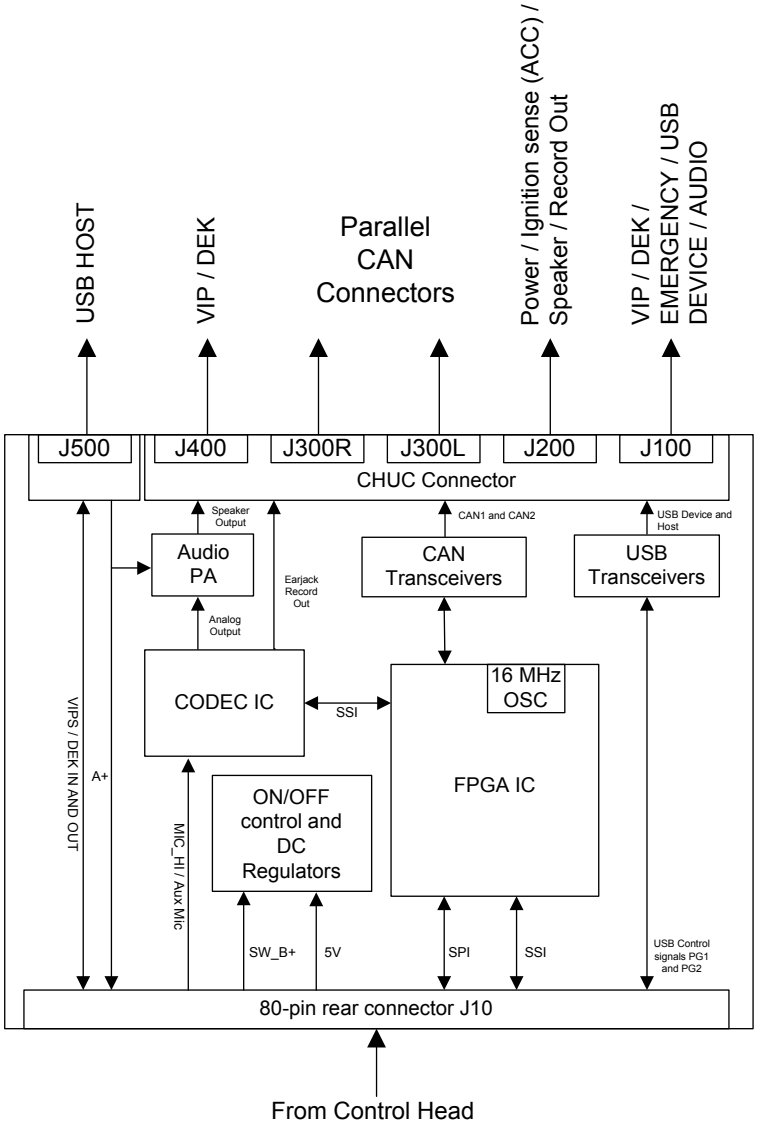
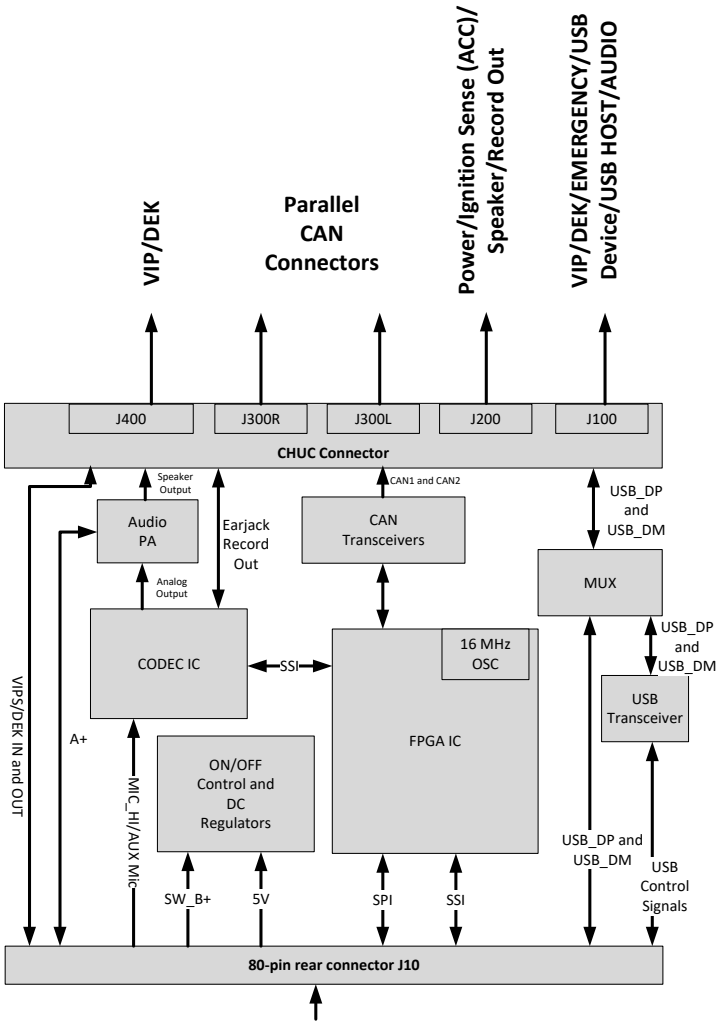


Figure 305: E5 Control Head Interface Board (CHIB) Functional Block Diagram



NOTE: O2, O7 and E5 CHIB uses different components for Audio PA and CODEC IC compared to O5 CHIB, and it can be only used with O2 and O7 Control Head.

10.13

APX Mobile Radio Transceiver Interface Board (TIB) Functional Block Diagram

Figure 306: APX Mobile Radio Transceiver Interface Board (TIB) Functional Block Diagram

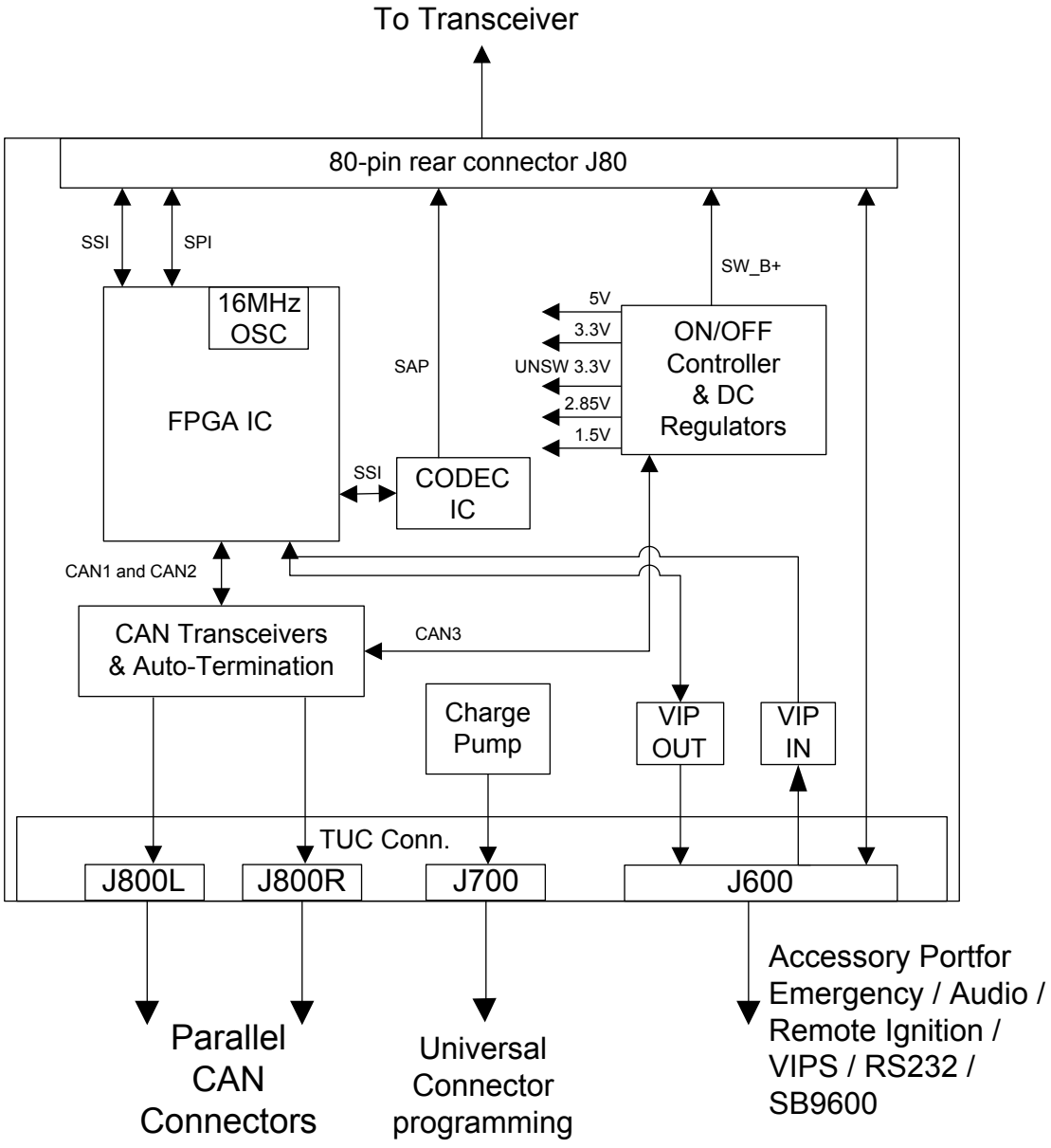
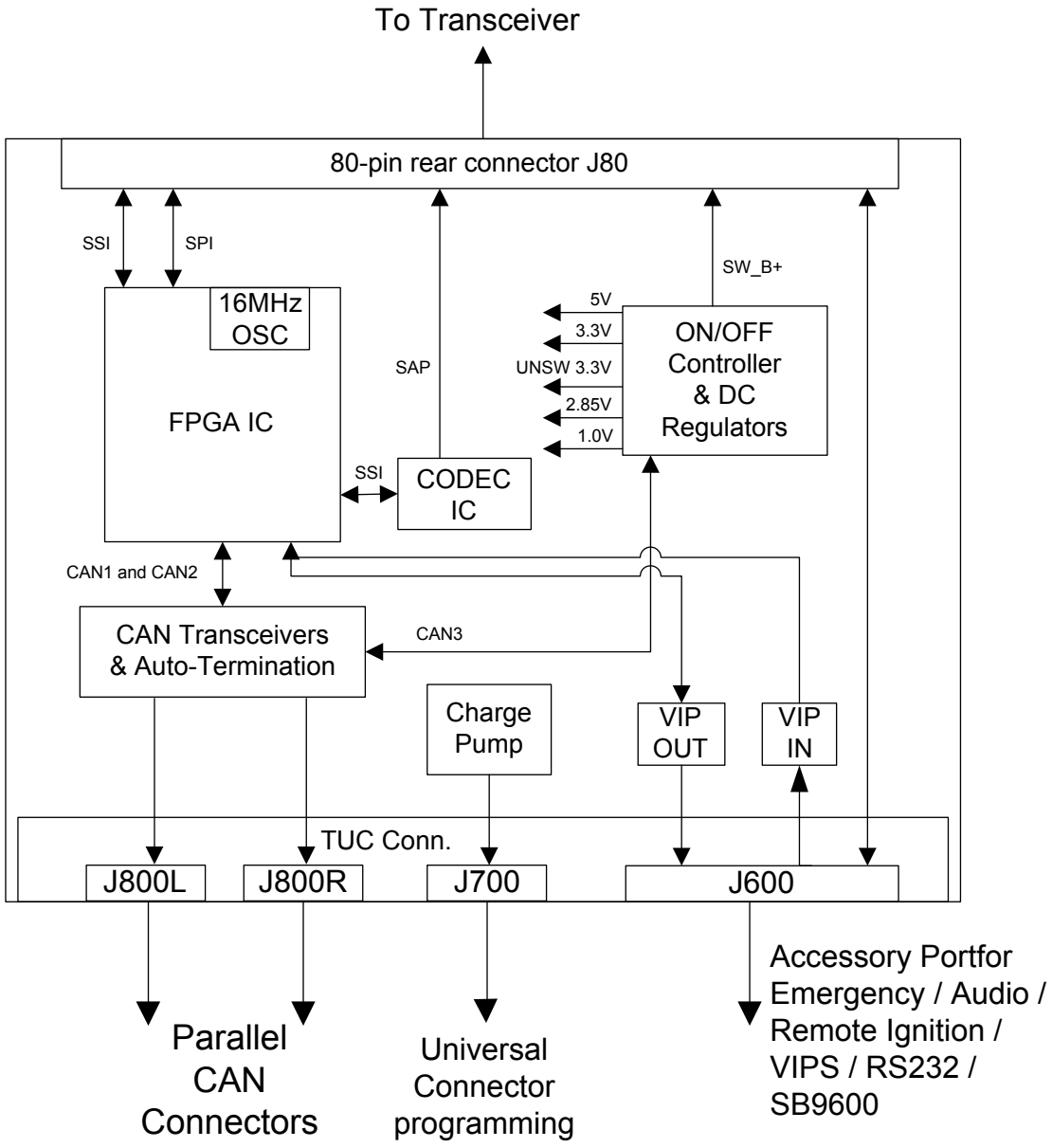


Figure 307: APX Mobile Radio Transceiver Interface Board (TIB) Functional Block Diagram Applicable for PMUN1083_Rev D and Onwards



10.14
O3 Radio Connector Locations

10.14.1
Mid Power Only

Figure 308: O3 Dash-Mount Radio Connector Locations (Mid Power Only)

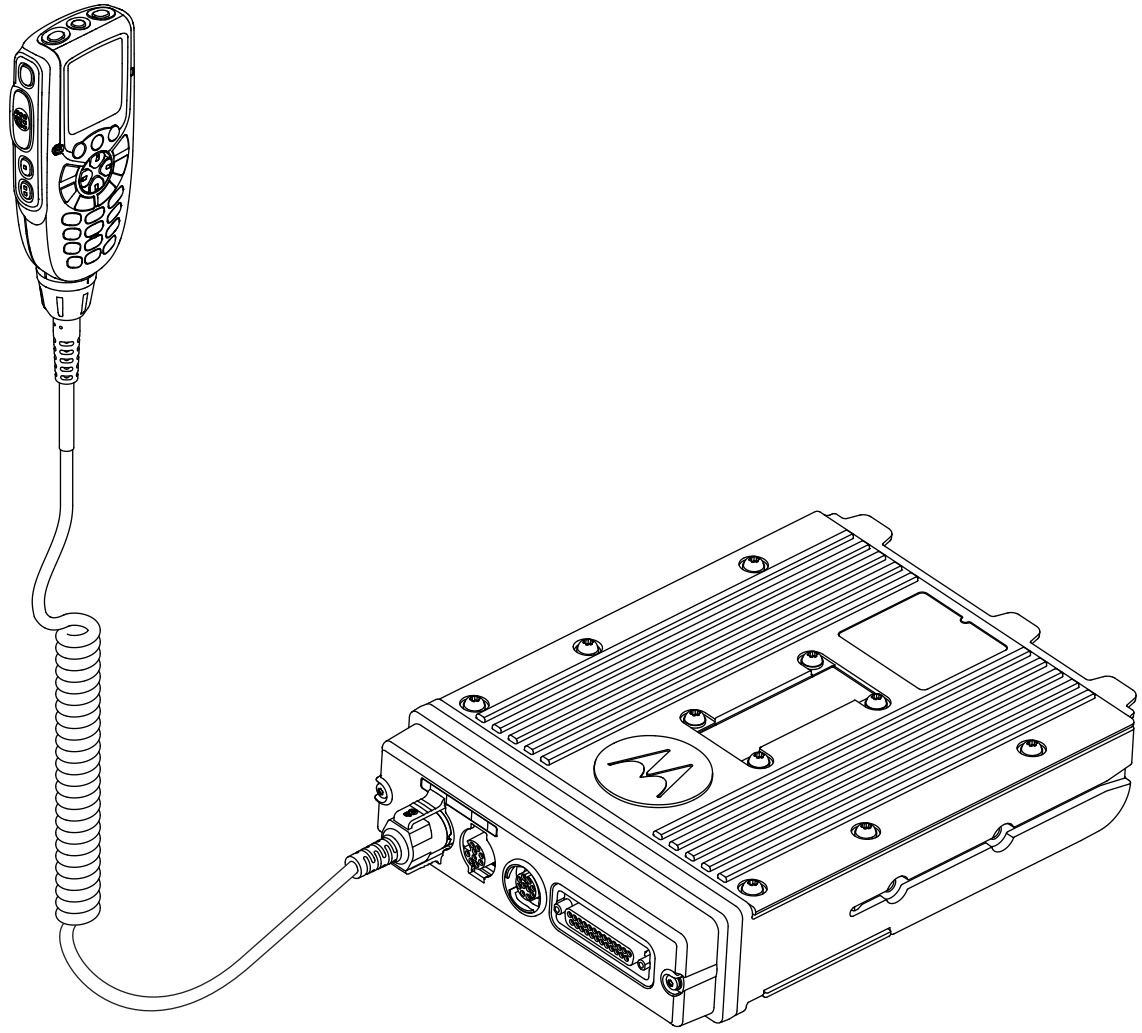
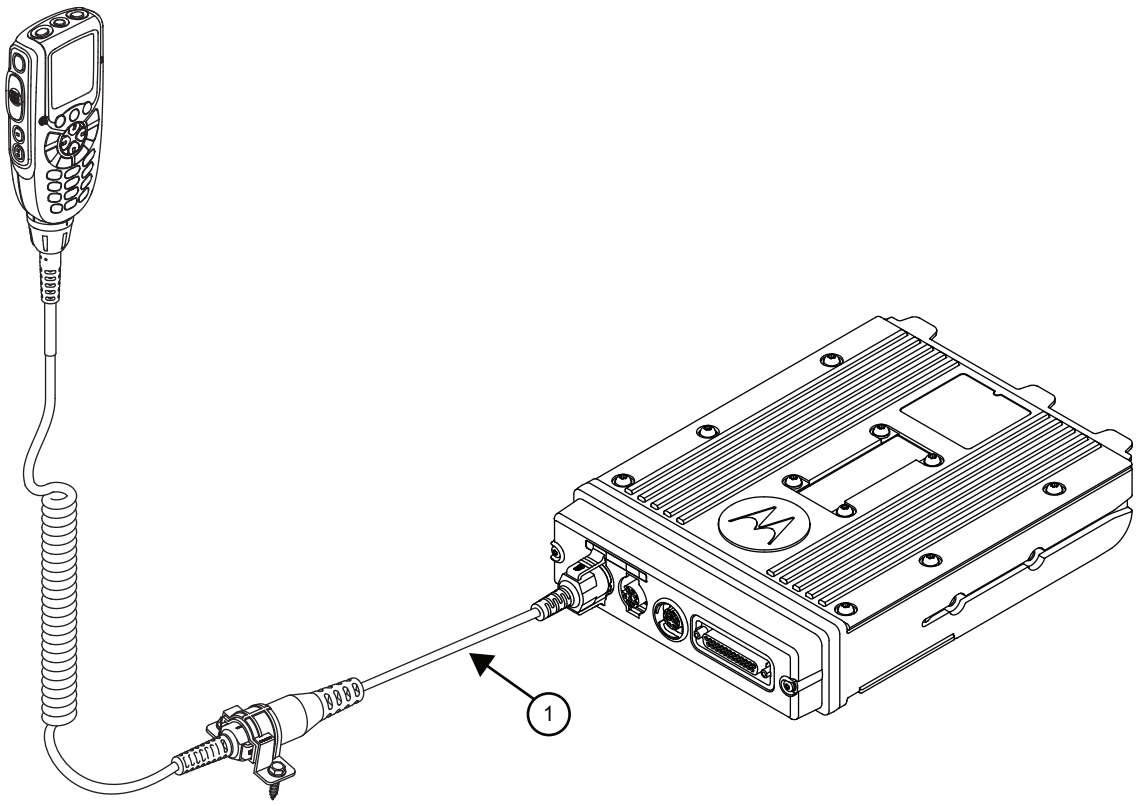


Figure 309: O3 Remote-Mount Radio Connector Locations

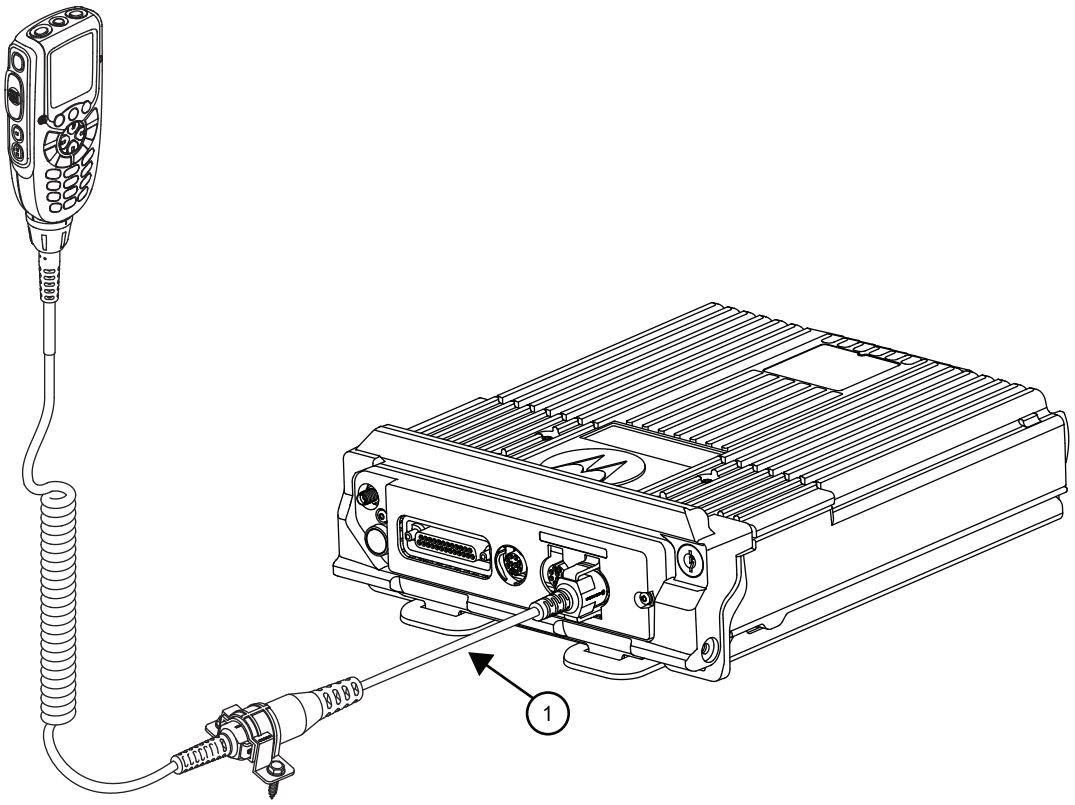


1	17 inch extension cable

10.14.2

High Power Only

Figure 310: O3 Remote-Mount Radio Connector Locations (High Power Only)



1	17 inch extension cable

10.15
O5 Radio Connector Locations

10.15.1
Mid Power Only

Figure 311: O5 Dash-Mount Radio Connector Locations (Mid Power Only)

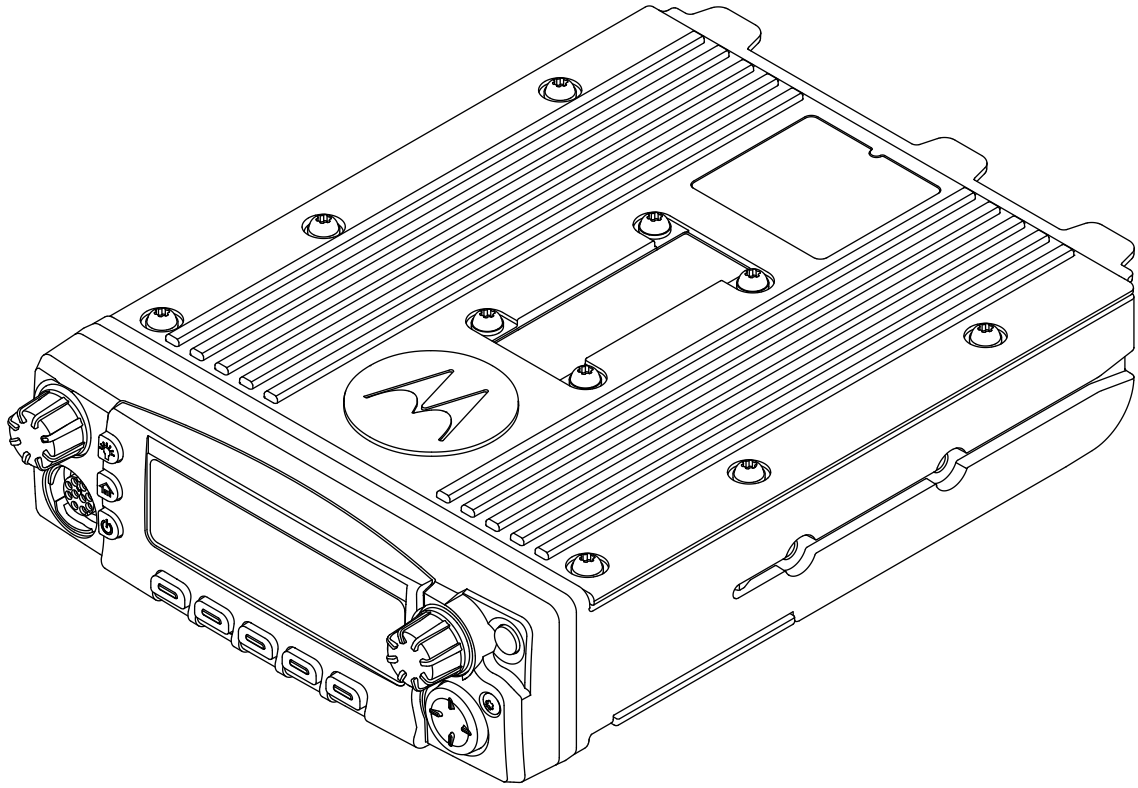
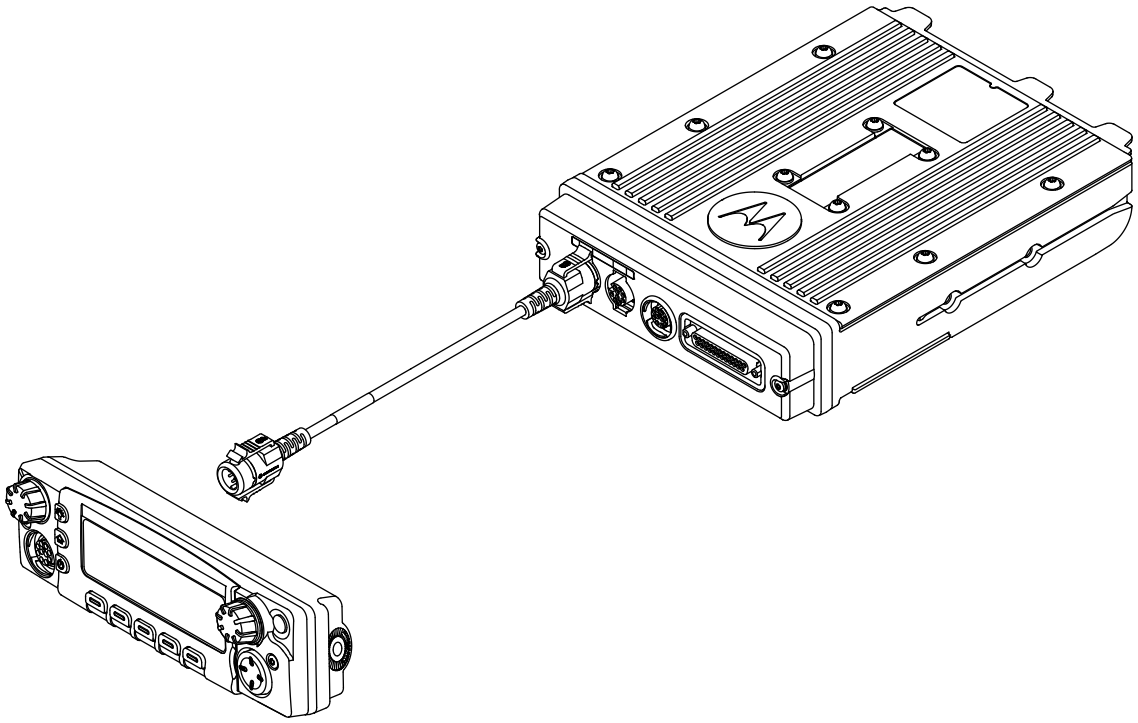
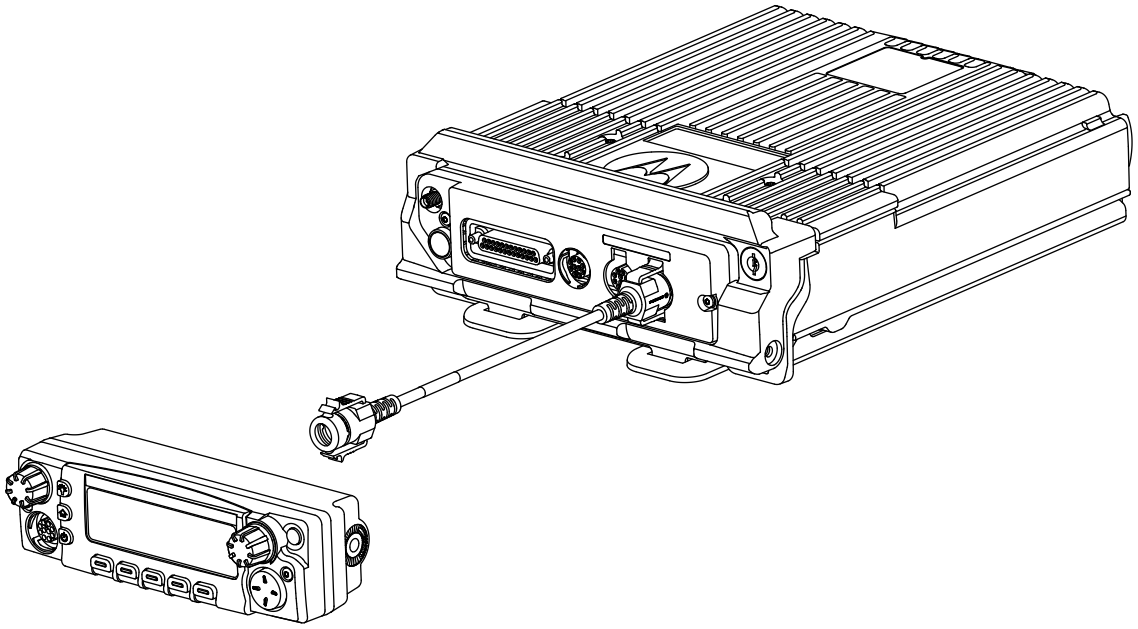


Figure 312: O5 Remote-Mount Radio Connector Locations (Mid Power Only)



10.15.2
High Power Only

Figure 313: O5 Remote-Mount Radio Connector Locations (High Power Only)



10.16
E5 Radio Connector Locations

10.16.1
Mid Power Only

Figure 314: E5 Dash-Mount Radio Connector Locations (Mid Power Only)

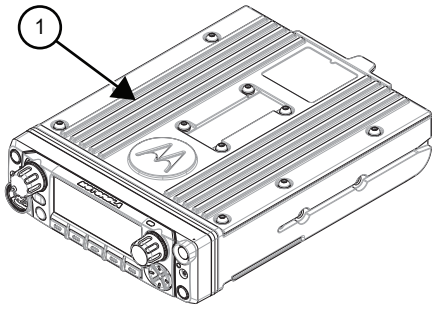
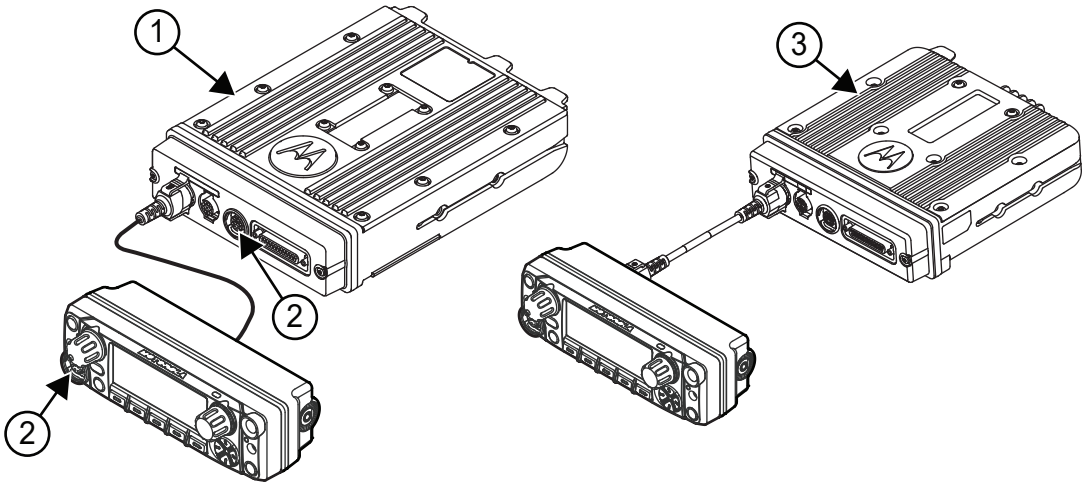


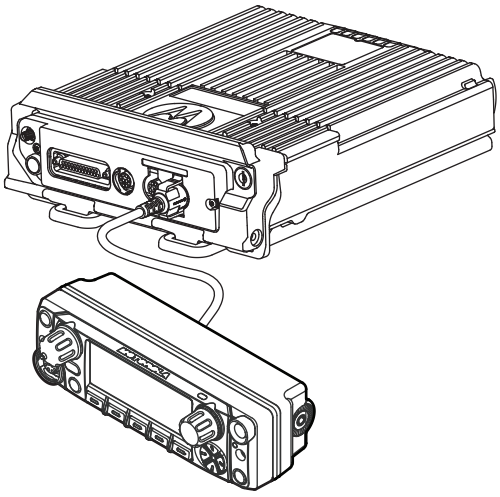
Figure 315: E5 Remote-Mount Radio Connector Locations (Mid Power Only)



No.	Description
1	ASTRO 25 Subscribers APX 5500/APX 6500/APX 7500/APX 6500 Li Mobile
2	MMP
3	ASTRO 25 Subscribers APX 2500/APX 4500

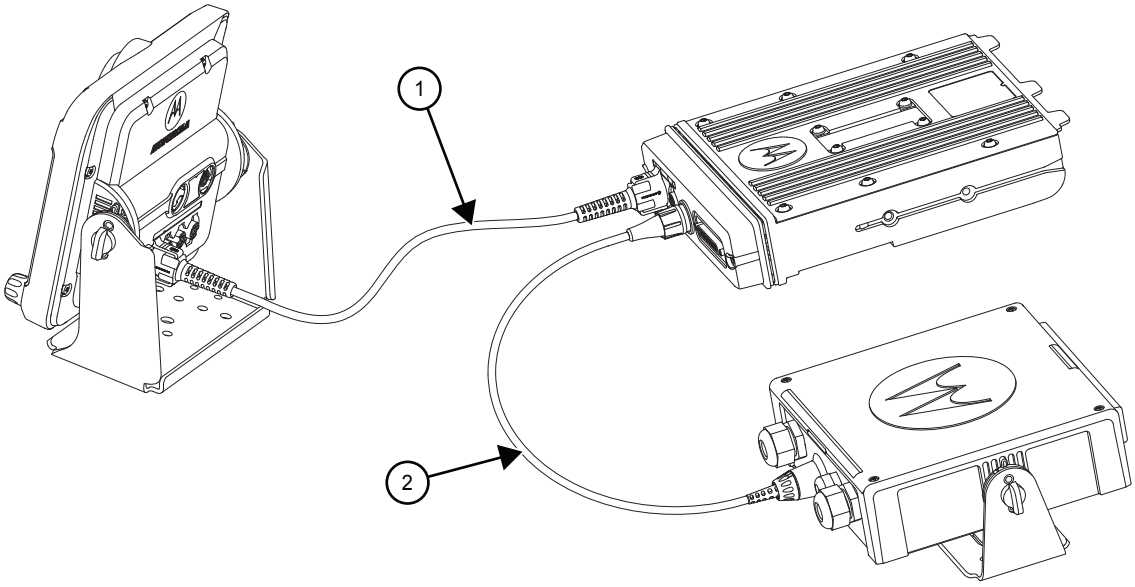
10.16.2
High Power Only

Figure 316: E5 Remote-Mount Radio Connector Locations (High Power Only)



10.17
O9 Transceiver Interface

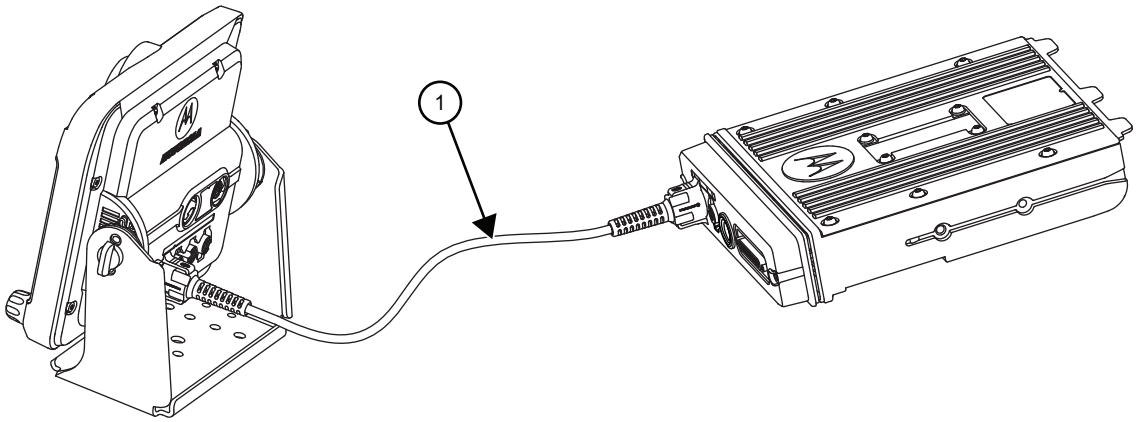
Figure 317: Transceiver Interface Board (TIB), Universal Relay Controller & Control Head View.



1	17 inch extension cable
2	O9 to URC cablee

NOTE: (URC is an optional accessory).

Figure 318: Remote-Mount Configuration with 100 W or Higher Power Radio



1	17 inch extension cable

Chapter 11

Exploded Views and Parts Lists

This chapter contains the exploded views and associated parts lists for the ASTRO APX Mobile radio and accessories. Tables containing push button parts lists are also included at the end of this chapter.

Table 80: Table of Exploded Views

Exploded Views
Figure 319: O2 Control Head Exploded View on page 340
Figure 320: O3 Control Head Exploded View on page 342
Figure 321: O5 Control Head Exploded View on page 343
Figure 322: O7 Control Head Exploded View on page 345
Figure 323: O9 Control Head Exploded View on page 347
Figure 321: O5 Control Head Exploded View on page 343
Figure 325: O2 CHIB and CHUC Exploded View on page 351
Figure 326: O5 CHIB and CHUC Exploded View on page 352
Figure 327: O7 CHIB and CHUC Exploded View on page 354
Figure 328: E5 CHIB and CHUC Exploded View on page 356
Figure 329: Transceiver Interface Board (TIB) Exploded View on page 357
Figure 330: APX 2500/4500/4500Li/1500 O2 Dash Mount Radio Exploded View on page 358
Figure 331: APX 2500 O3 Radio Exploded View on page 360
Figure 332: APX 2500 O7 Dash Mount Radio Exploded View on page 362
Figure 333: APX 5500/6500/7500/6500 Li O2 Dash Mount Radio Exploded View on page 364
Figure 334: APX 5500/6500/7500/6500 Li O3 Radio Exploded View on page 366
Figure 335: APX 5500/6500/7500/6500 Li O5 Dash Mount Radio Exploded View on page 368
Figure 337: APX 2500/4500 O5 Dash Mount Radio Exploded View on page 372
Figure 339: APX 5500/6500/7500/6500 Li O7 Dash Mount Radio Exploded View on page 376
Figure 340: APX 5500/6500/7500/6500 Li 100 W Remote Mount Radio Exploded View on page 378
Figure 341: Universal Relay Controller Exploded View on page 380

11.1

O2 Control Head Exploded View and Parts List

Figure 319: O2 Control Head Exploded View

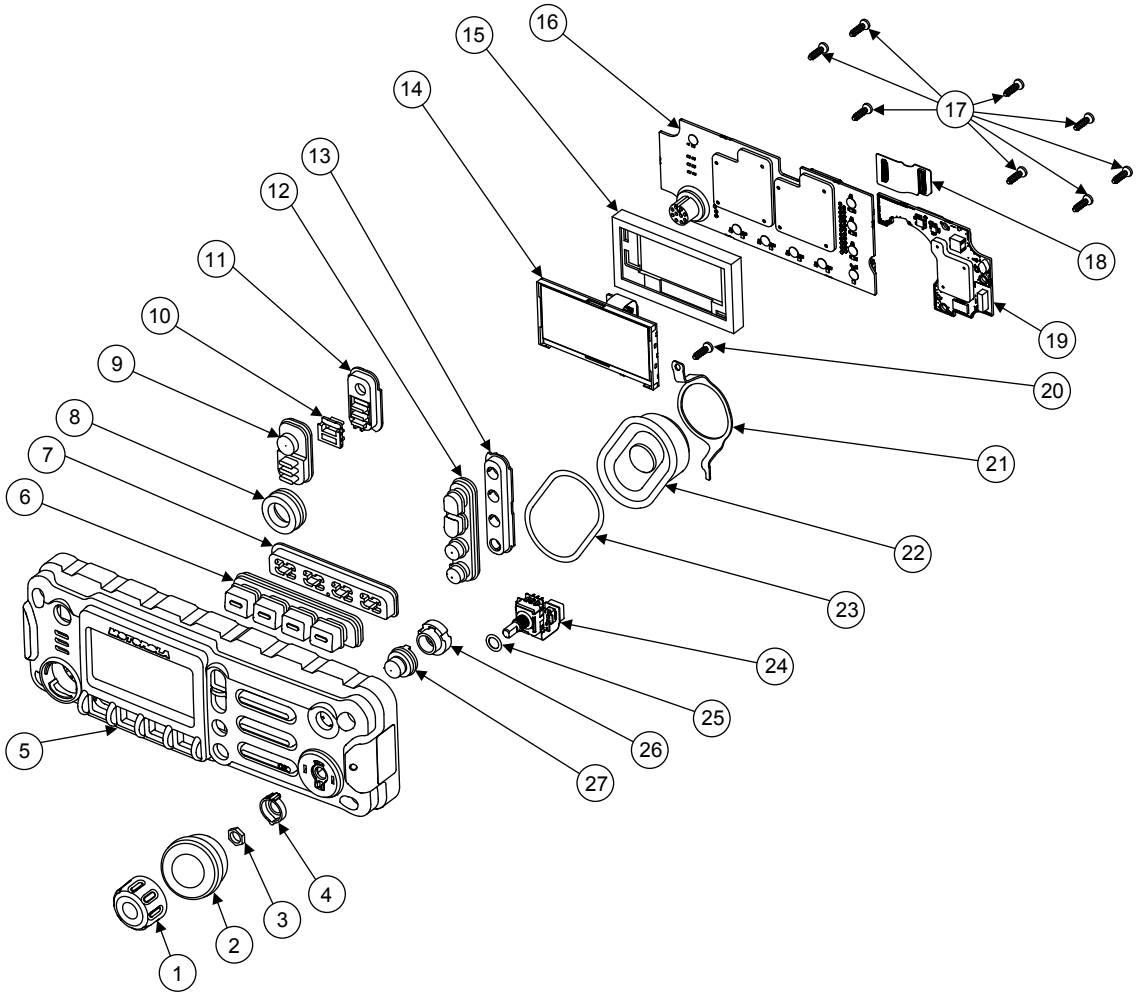


Table 81: O2 Control Head Parts List

Item No.	Motorola Solutions Part No.	Description
1	36012023002	Knob, Encoder
2	36012035001	Knob[6], Emergency
3	02012021001	Nut, Hex
4	42012071001	Spring, Detent
5	0104058J01 (Grey) 0104058J02 (Green)	Housing, Front Assembly (Includes LIGHT GUIDE, Encoder, 61012062001 and LENS, Display, 61012060001)

[6] This is an optional part, and it can only be used with APX 6500/6500Li/4500/4500Li/1500. This item cannot be ordered individually. It is included in the O2 EMERGENCY KNOB KIT_PMBN4135.

Item No.	Motorola Solutions Part No.	Description
6	75012155002	Keypad, Soft Key
7	42012066002	Retainer, Soft Key Keypad
8	3264133H01	Seal, GCAI
9	38012028001	Keypad, Power and Status Indicator
10	07012039001	Light Isolator, Status Indicator
11	07012040001	Retainer, Power and Status Indicator Keypad
12	38012029002	Keypad, Home, Dimmer, P1 and P2
13	07012038001	Retainer, Home, Dimmer, P1 and P2 Keypad
14	72012018002	Display Module, LCD
15	75012151001	Dampener, LCD Display Module
16	PMLN5901_[7]	PCB, Control Head, Main
17	03012055001	Screw, PCB, Main and Option Board
18	0104046J24	Flex, Option Board
19	PMLN6054_[8]	PCB, Option Board
20	03012055001	Screw, Speaker Retention
21	42012070001	Retainer, Speaker
22	5015134H01	Speaker
23	11012103001	Adhesive, Speaker
24	0104046J20	Potentiometer, Encoder Assembly
25	32012152001	Seal, O-ring, Encoder
26	07012041001	Retainer, Emergency Button Keypad
27	38012030001	Keypad, Emergency Button

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

[7] These items cannot be ordered individually. They are included in PMLN6342_.
[8] These items cannot be ordered individually. They are included in PMLN6341_.

11.2

O3 Control Head Exploded View and Parts List

Figure 320: O3 Control Head Exploded View

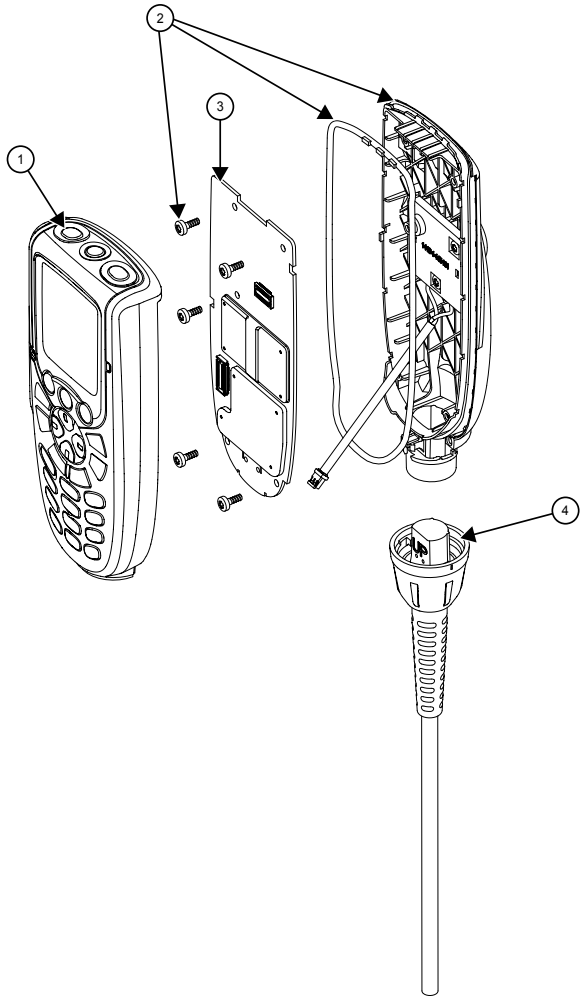


Table 82: O3 Control Head Parts List

Item No.	Motorola Solutions Part No.	Description
1	PMHN4082_	Housing, Front, Service Kit for PMUN1034A & PMUN1034B (English)
	PMHN4174_	Housing, Front, Service Kit for PMUN1034C or above (English)
	PMHN4199_	Housing, Front, Service Kit for PMUN1052B or above (Hebrew)
	PMHN4198_	Housing, Front, Service Kit for PMUN1053A or above (Cyrillic)
	PMHN4202_	Housing, Front, Service Kit for PMUN1054A or above (Arabic)

Item No.	Motorola Solutions Part No.	Description
	PMHN4235_	Housing, Front, Service Kit for PMUN4227A or above (Siren & Lights)
2	PMHN4083_	Housing, Back, Service Kit (Includes O-ring [Quantity 1] and screws, 0310944A02 [Quantity 5])
3	PMLN5035_	PCB Service Kit (for PMUN1034A and PMUN1034B)
	PMLN5848_	PCB Service Kit (for PMUN1034C or above, PMUN1052B or above, PMUN1053A or above, PMUN1054A or above, PMUN4227A or above)
4	PMLN4961_	Cable, Coiled, Kit

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

11.3

O5 Control Head Exploded View and Parts List

Figure 321: O5 Control Head Exploded View

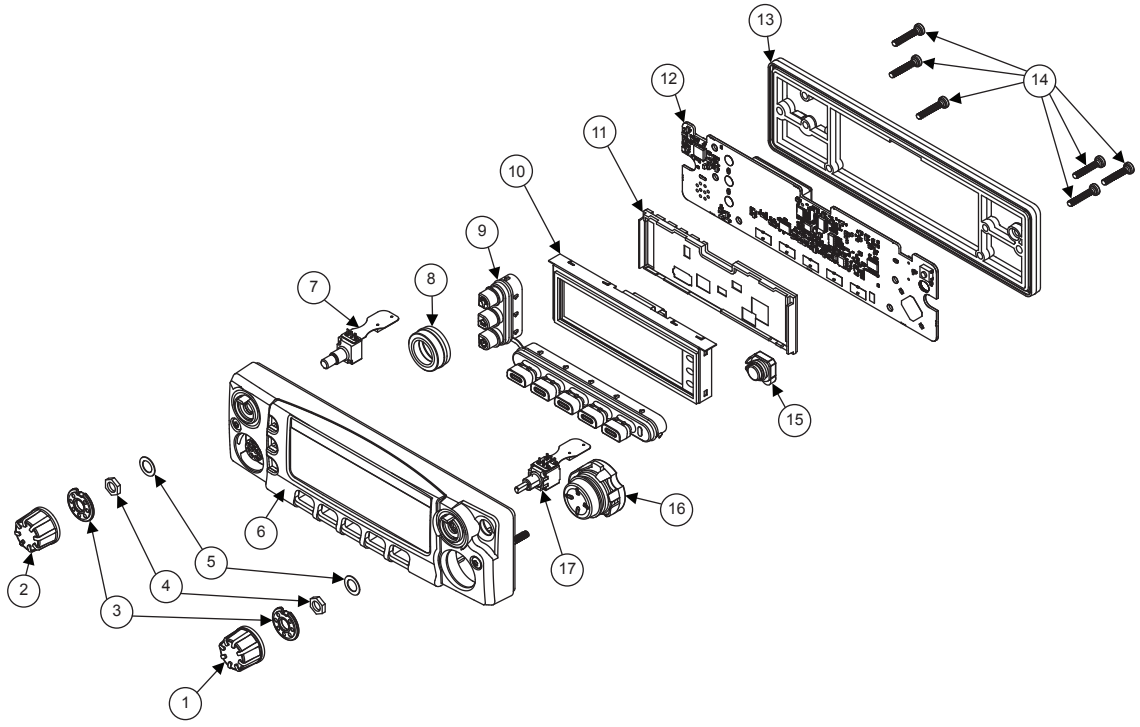


Table 83: O5 Control Head Parts List

Item No.	Motorola Solutions Part No.	Description
1	3664445H01	Knob, Mode
2	3664022H01	Knob, Volume
3	0415285H01	Washer, Torque

Item No.	Motorola Solutions Part No.	Description
4	0215000C01	Nut, Hex, Special
5	0402838X01	Washer, 3 Wave
6	1564047H06	Housing, Front Assembly (Includes Light pipe, Vol/Select, 6164056H02, [Quantity 2])
7	1864069H01	Potentiometer, Volume Assembly
8	3264133H01	Seal, O-Ring, MMP
9	3864503H05	Buttons, Main Assembly
10	7264052H05	Display, LCD
11	2675960A01	Shield, LCD
12	HLN6911_	PCB, Control Head Main
13	3264059H02	Seal, Overmolded Frame
14	0310944A14	Screws, Mounting
15	3864502H02	Button, Emergency
16	3864499H04	Button, Navigation Assembly
17	4064073H01	Switch, Frequency Assembly

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

11.4

O7 Control Head Exploded View and Parts List

Figure 322: O7 Control Head Exploded View

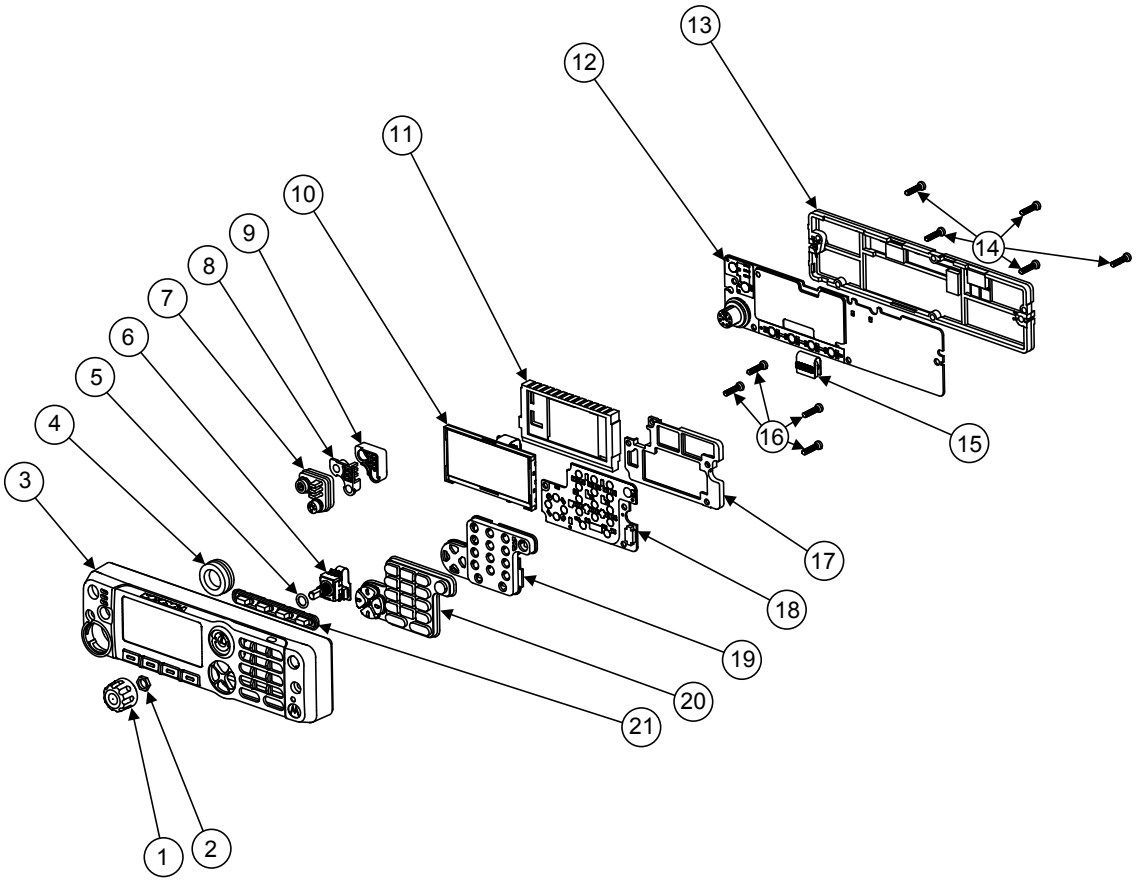


Table 84: O7 Control Head Parts List

Item No.	Motorola Solutions Part No.	Description
1	36012022001	Knob, Encoder
2	02012021001	Nut, Hex
3	0104047J41	Housing, Front Assembly (Includes LIGHT GUIDE, Encoder, 61012059001, LENS, Display, 61012061001 and SNAP PLUNGERS, Softkey, 55012025001)
4	3264133H01	Seal, GCAI
5	32012152001	Seal, O-ring, Encoder
6	0104046J14	Potentiometer, Encoder Assembly
7	75012149001	Keypad, Power, Dimmer and Status Indicator
8	61012058001	Light Guide, Power, Dimmer and Status Indicator
9	42012065001	Retainer, Power, Dimmer and Status Indicator Keypad

Item No.	Motorola Solutions Part No.	Description
10	72012018002	Display Module, LCD
11	75012152001	Dampener, LCD Display Module
12	PMLN5900_[9]	PCB, Control Head, Main
13	42012067001	Retainer, PCB, Main
14	0371370L02	Screws, Retention, PCB, Main
15	0104046J27	Flex, Bluetooth
16	03012055001	Screws, Retention, PCB, Bluetooth
17	42012069001	Retainer, PCB, Bluetooth
18	PMLN5983_[10]	PCB, Bluetooth
19	42012068001	Retainer, DTMF Keypad
20	75012157001 (English) 75012157002 (English_Chinese) 75012157003 (English_Cyrillic) 75012157004 (English_Hebrew) 75012157005 (Siren and Light) 75012157006 (English_Arabic)	Keypad, DTMF
21	75012153001	Keypad Rubber, Soft Key

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

[9] These items cannot be ordered individually. They are included in PMLN6340_.
[10] These items cannot be ordered individually. They are included in PMLN6343_.

11.5

O9 Control Head Exploded View and Parts List

Figure 323: O9 Control Head Exploded View

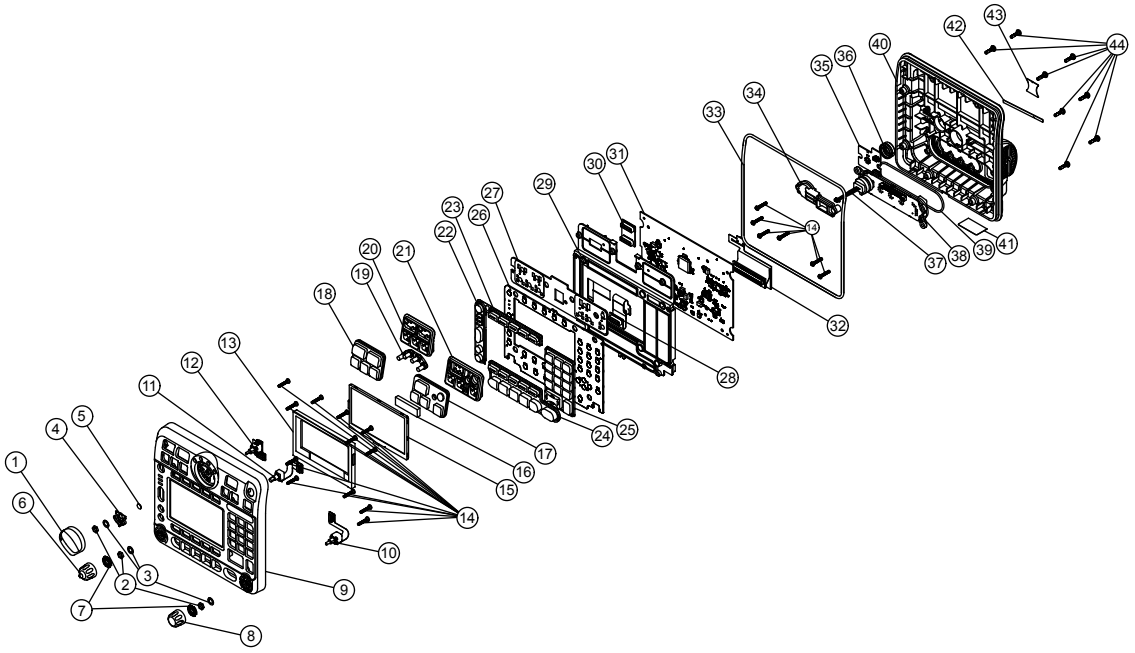


Table 85: O9 Control Head Parts List

Item No.	Motorola Solutions Part No.	Description
1	3675872M02	Top Pursuit Knob
2	0215000C01	Nut
3	0402838X01	Washer
4	42012000001	Pursuit Spring
5	3205472M02	Gore Port Seal
6	3675893M01	Volume Knob
7	3275895M01	Torque Enhancer
8	3675898M01	Frequency Knob
9	PMHN4143_	Front Housing Assembly (with light guides)
10	0104031J86	Frequency Flex Assembly
11	0104031J85	Volume Flex Assembly
12	0104033J49	Top Pursuit Switch Flex Assembly
13	7575913M01	Rubber jacket/ Rubber Boot
14	0371370L02	Screw, Tapping, K30X1.34X16
15	7275224M01	LCD Module/Display
16	32012043001	Conductive Pad, LCD
17	7575866M01	Top Pursuit Light Bar Keypad

Item No.	Motorola Solutions Part No.	Description
18	7575867M01	Top Pursuit Siren Keypad
19	6175865M01	Indicator Light Guide
20	4275869M01	Top Pursuit Siren Keypad Retainer
21	4275868M01	Top Pursuit Light Bar Keypad Retainer
22	7575911M02	Menu, Brightness Control Keypad
23	7575912M02	DEK Silicone Keypad
24	7575911M01	Programmable Control Keypad
25	7575912M01 7575912M03	Alpha Numeric Silicone Keypad Alpha Numeric Silicone Keypad, Arabic
26	PMLN5601_	Front Keypad PCB Kit (with mylar)
27	PMLN5602_	Top keypad PCB Kit (with mylar)
28	0104033J13	Front Keypad Flex
29	2775878M02	Chassis with Thermal Pad
30	0104031J84	Top Keypad Flex Assembly
31	PMLN5637_	Main PCB Kit
32	0104033J12	Main Flex Assembly
33	3275880M01	Main O-ring
34	4278089A01	USB/GCAI Retainer
35	PMLN5638_	GCAI PCB Kit
36	3264133H01	GCAI Seal
37	0964098H01	USB Overmold
38	HLN6914_	CHUC PCB Kit
39	3264096H01	CHUC Seal
40	1575879M02	Back Housing with Screw Insert
41	54012001001	Label, Serial
42	3364425H01	Label Color Code
43	5475881M01	Label Connector
44	0378014A01	Screw Assembly (M3X0.5X14 mm)

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

11.6

E5 Control Head Exploded View and Parts List

Figure 324: E5 Control Head Exploded View

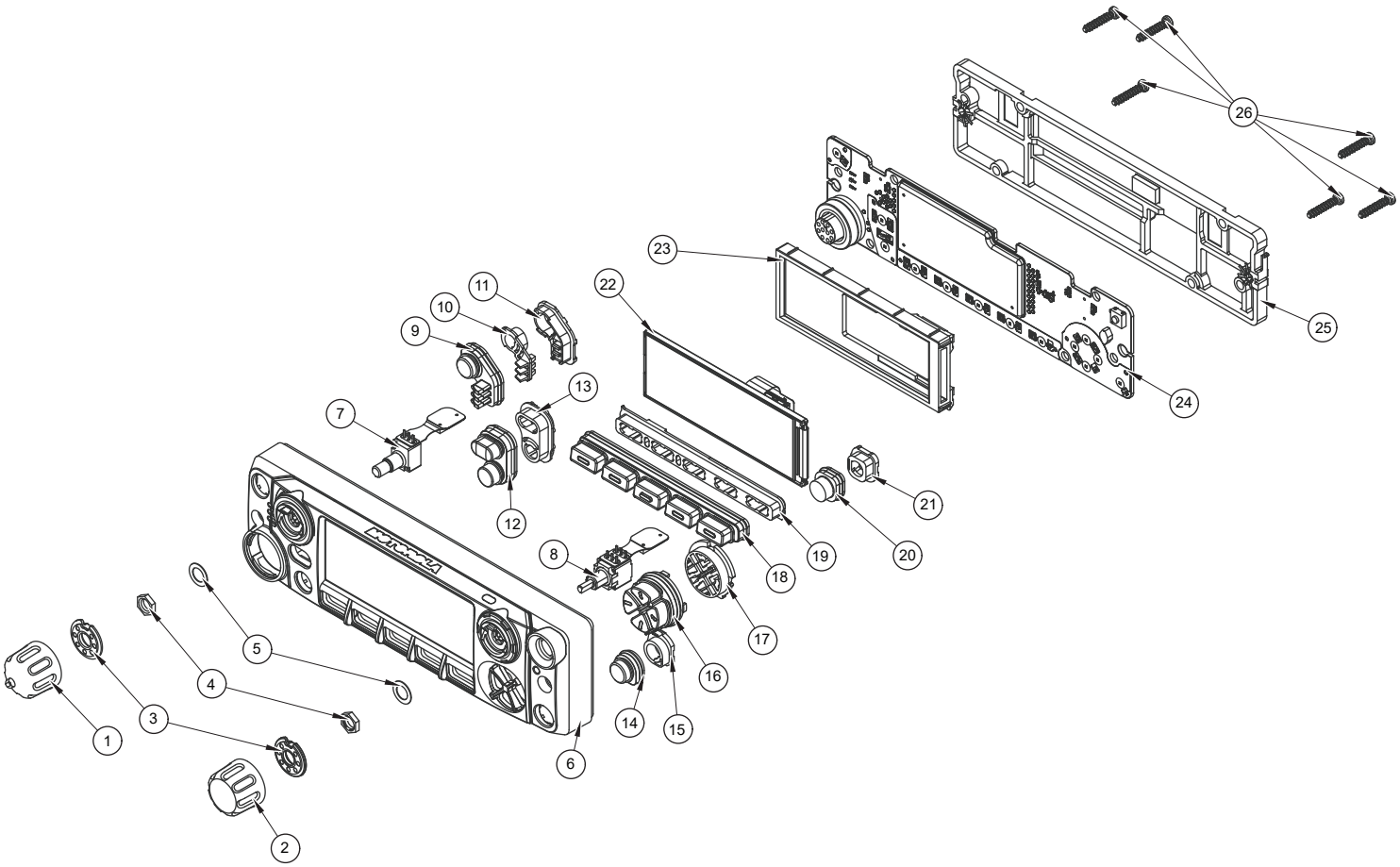


Table 86: E5 Control Head Parts List

Item No.	Motorola Solutions Part No.	Description
1	HW002144A01	Knob, volume, E5
2	HW002145A01	Knob, Frequency, E5
3	0415285H01	Washer, Torque
4	0215000C01	Nut, Hex, M6, Steel, Hex, Special
5	0402838X01	Washer, 3 Wave
6	0104080J95	E5 Front Housing Assembly
7	1864069H01	Potentiometer, Volume Assembly
8	4064073H01	Switch, Frequency Assembly
9	KP000186A01	Button, Light Indicator, Power
10	HW002156A01	Light Guide, Power

Item No.	Motorola Solutions Part No.	Description
11	HW002150A01	Retainer, Power Button
12	KP000183A01	Button, Programmable
13	HW002147A01	Retainer, Programmable
14	KP000188A01	Button, Home
15	HW002163A01	Retainer, Home
16	KP000184A01	Button, Navigation
17	HW002148A01	Retainer, Navigation
18	KP000182A01	Button, Menu
19	HW002146A01	Retainer, Menu
20	KP000185A01	Button, Emergency
21	HW002149A01	Retainer, Emergency
22	DM000141A01	Color Display Module, 160 RGBx480 TFT, Transmissive
23	HW002169A01	Display Rubber Boot
24	PMLN7988_[11]	PCB, Main Board
25	HW002151A01	PCB Retainer
26	0371370L02	Screw, K30 PT Thread

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

[11] This item cannot be ordered individually. It is included in PPMLN7988_

11.7

O2 CHIB and CHUC Exploded View and Parts List

Figure 325: O2 CHIB and CHUC Exploded View

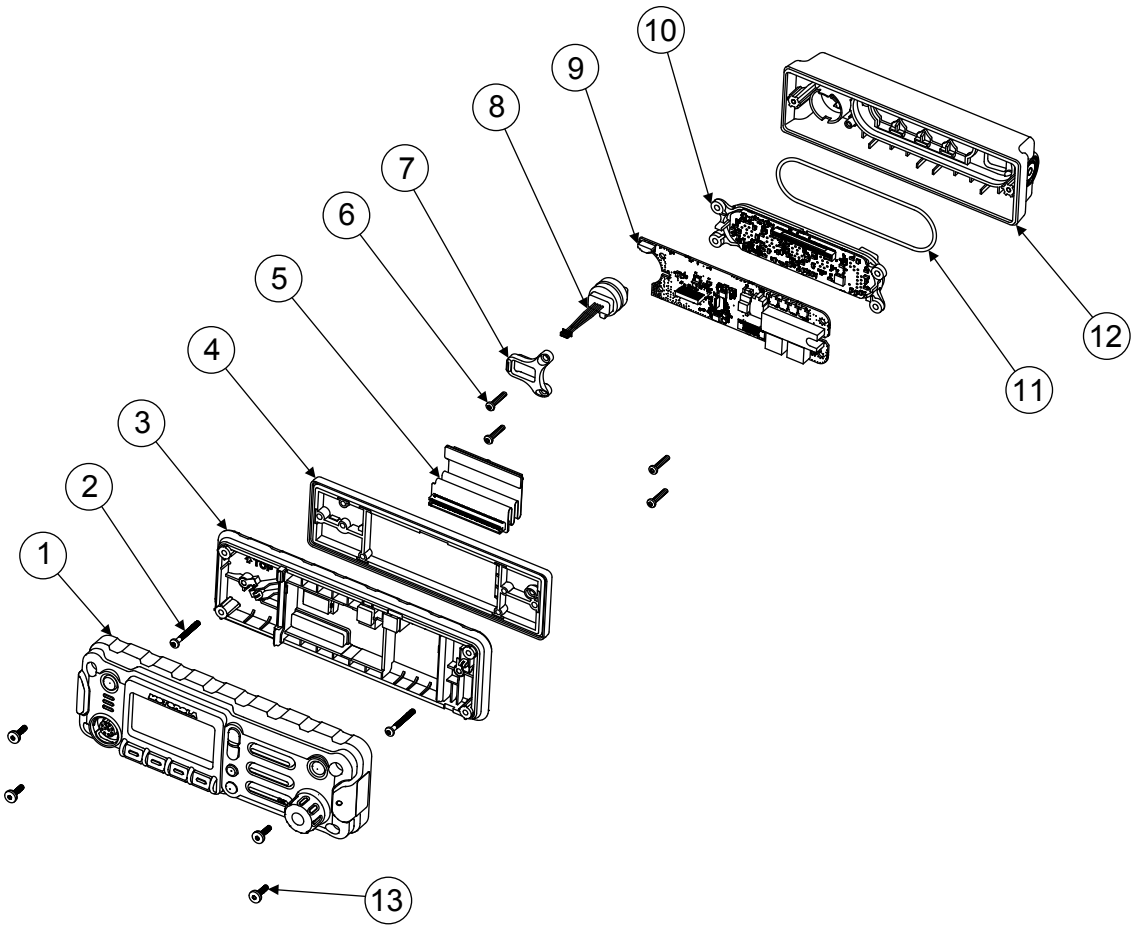


Table 87: O2 CHIB and CHUC Parts List

Item No.	Motorola Solutions Part No.		Description
1		PMHN4193_ PMHN4195_	O2 Control Head Grey O2 Control Head Green
2		03012052001	Transceiver Screws
3		0104046J72	O2 Back Housing Sub-assembly
4		3264059H03	I-Seal
5		0104046J13	Remote Mount Flex Assembly
6	PMUN1057_/ PHCN4003_**[12]	0310909F21	Screw, Tapping (4)
7		0764091H01	Bracket, USB Connector
8		0964098H01	USB Connector[13]

[12] When ordering, refer to your specific kit number and suffix letter to ensure compatibility.
[13] This item is not applicable for PHCN4003_**.

Item No.	Motorola Solutions Part No.		Description
9	PMUN1057_/ PHCN4003_**[12]	PMLN5927_ / PMLN8045_[14]	CHIB Board Assembly
10		HLN6914_	CHUC Board Assembly
11		3264096H01	Seal, Moisture, Silicone
12		1564090H01	Housing
13		03012063001	Housing Retention Screws
*		HLN6980_	Kit, Dust Cover

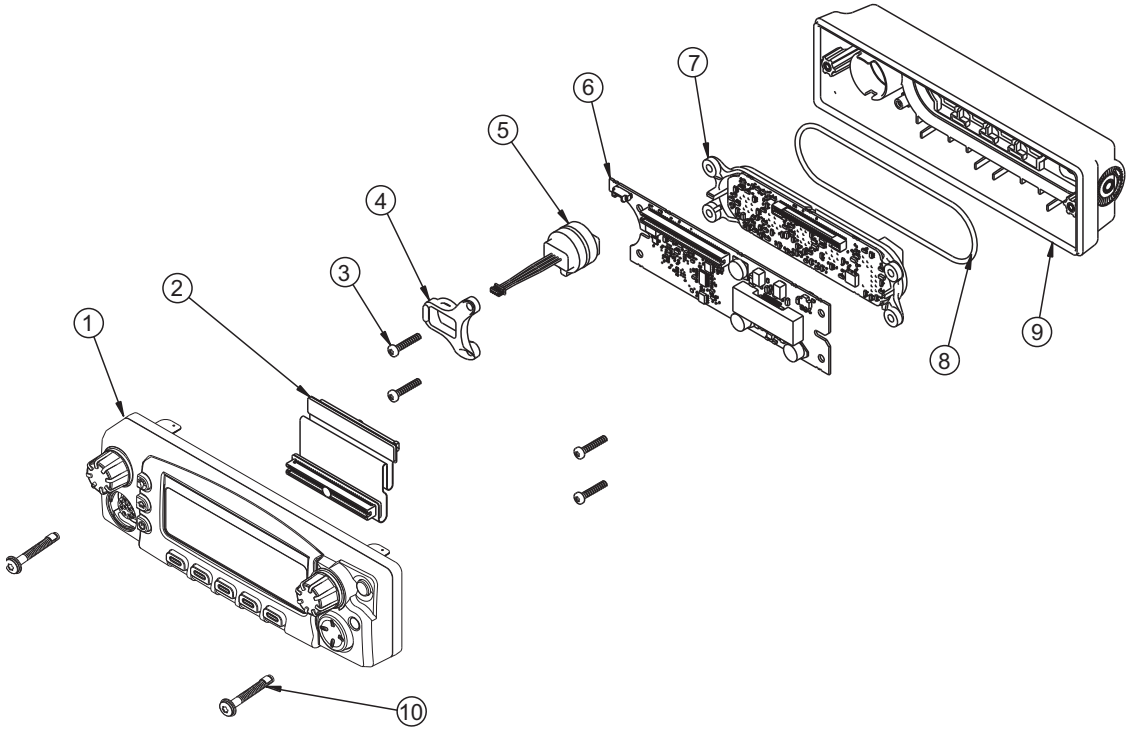
NOTE:

- The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.
- The double asterisk (**) indicates newer kit revision than PHCN4003E.

For more information on the compatibiliy of the Control Head and CHIB, refer to Table 26: Control Head and CHIB Compatibility on page 101.

11.8 O5 CHIB and CHUC Exploded View and Parts List

Figure 326: O5 CHIB and CHUC Exploded View



[14] This item cannot be ordered individually. This item is included in PMUN1057_/ PHCN4003_**.

Table 88: O5 CHIB and CHUC Parts List

Item No.	Motorola Solutions Part No.		Description
1		PHCN4000_	Control Head
2		HKN6191_	Flex Assembly
3	PHLN1002_	0310909F21	Screw
4		0764091H01	Retainer Bracket
5		0964098H01	USB Adapter
6		HLN7041_[15]	CHIB
7		HLN6914_	CHUC
8		3264096H01	Moisture Seal
9		1564090H01	Rear Housing
10		0364332H02	Main Screws
*		HLN6980_	Kit, Dust Cover
*		NNTN7279_	Sun Shield

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

[15] This item cannot be ordered individually. It is included in PHLN1002_.

11.9

O7 CHIB and CHUC Exploded View and Parts List

Figure 327: O7 CHIB and CHUC Exploded View

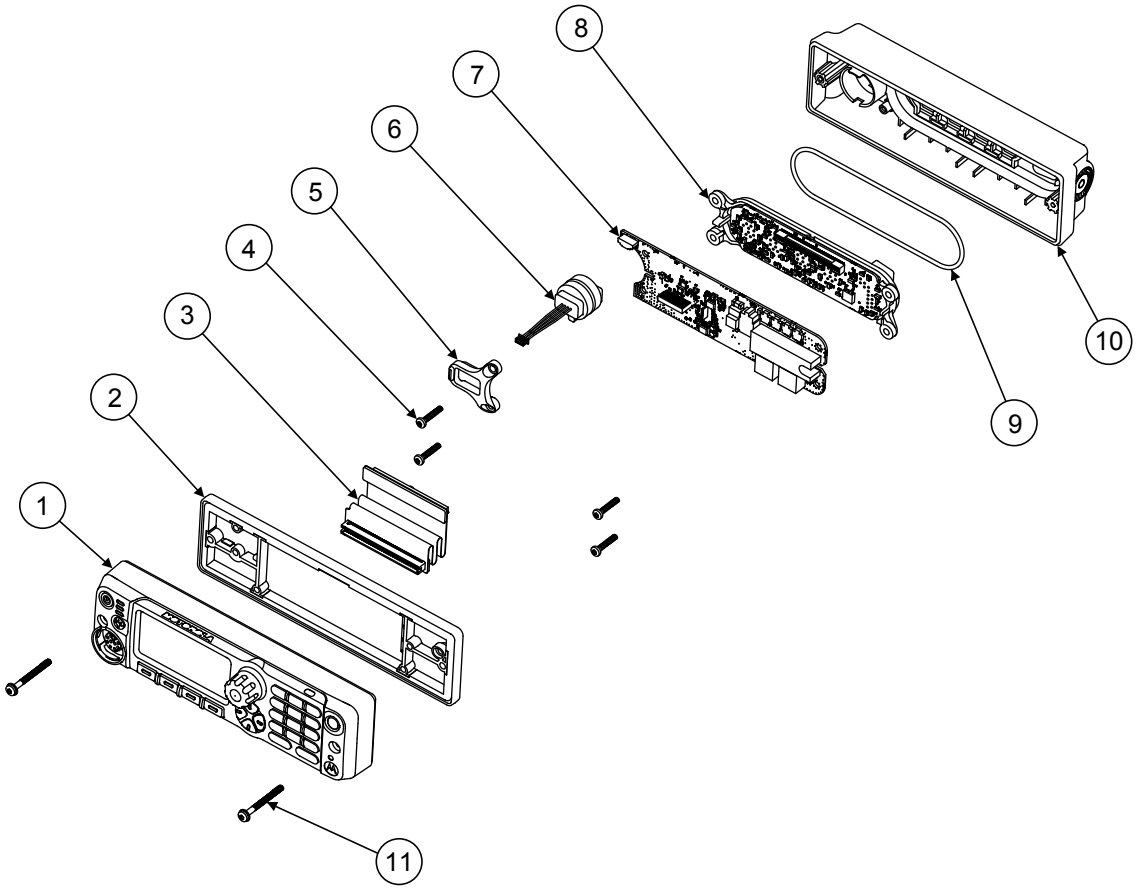


Table 89: O7 CHIB and CHUC Parts List

Item No.	Motorola Solutions Part No.		Description
1		PMHN4194_	O7 Control Head English
		PMHN4192_	O7 Control Head English_Chinese
		PMHN4197_	O7 Control Head English_Cyrillic
		PMHN4196_	O7 Control Head English_Hebrew
		PMHN4191_	O7 Control Head Siren and Light
		PMHN4229_	O7 Control Head English_Arabic
2		3264059H03	I-Seal
3		0104046J13	Remote Mount Flex Assembly
4	PMUN1057_/ PHCN4003_**[16]	0310909F21	Screw, Tapping (4)
5		0764091H01	Bracket, USB Connector
6		0964098H01	USB Connector[17]

[16] When ordering, refer to your specific kit number and suffix letter to ensure compatibility.

Item No.	Motorola Solutions Part No.		Description
7	PMUN1057_/ PHCN4003_**[16]	PMLN5927_/ PMLN8045_[18]	CHIB Board Assembly
8		HLN6914_	CHUC Board Assembly
9		3264096H01	Seal, Moisture, Silicone
10		1564090H01	Housing
11		03012062001	Transceiver Screws
*		HLN6980_	Kit, Dust Cover

NOTE:

- The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.
- The double asterisk (**) indicates newer kit revision than PHCN4003E.

For more information on the compatibiliy of the Control Head and CHIB, refer to Table 26: Control Head and CHIB Compatibility on page 101.

[17] This item is not applicable for PHCN4003_**.
[18] This item cannot be ordered individually. This item is included in PMUN1057_/ PHCN4003_**.

11.10

E5 CHIB and CHUC Exploded View and Parts List

Figure 328: E5 CHIB and CHUC Exploded View

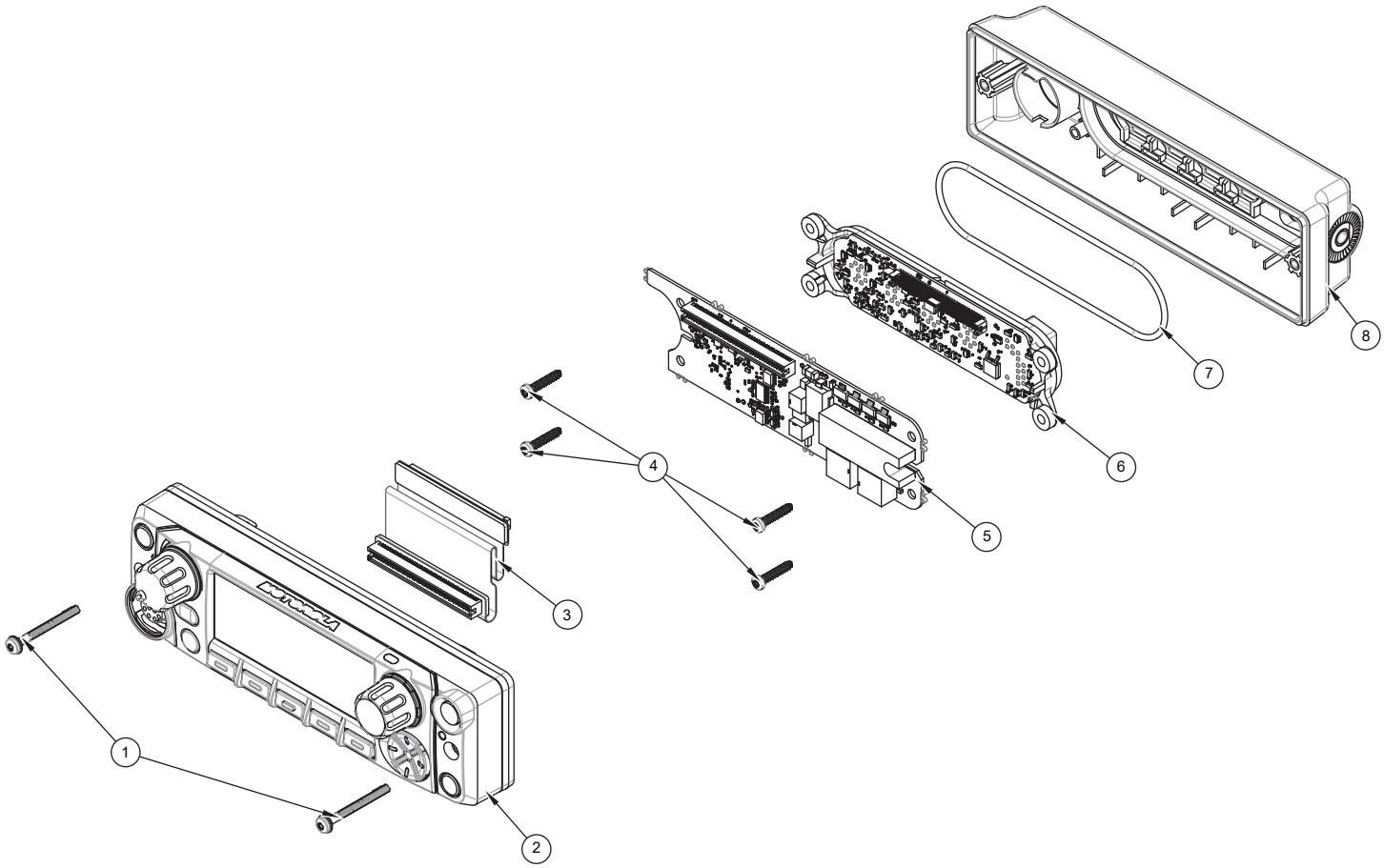


Table 90: E5 CHIB and CHUC Parts List

Item No.	Motorola Solutions Part No.	Description
1	3012062002	Screw Assembly, Transceiver, E5
2	PHCN4001A	E5 Control Head
3	PA002638A01	E5 Remote Flex
4	0310909F21[19]	Screw
5	PMLN8045_[19]	E5 CHIB Board
6	PMLN8052A[19]	E5 CHUC Board
7	3264096H01[19]	Seal, O-ring CHUC
8	1564090H02[19]	E5 Remote Mount Housing

[19] This item cannot be ordered individually. It is included in PHCN4003_.

Item No.	Motorola Solutions Part No.	Description
*	HLN6980_	Kit, Dust Cover

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

11.11

Transceiver Interface Board (TIB) Exploded View and Parts List

Figure 329: Transceiver Interface Board (TIB) Exploded View on page 357 represents the interface board for all remote mount configurations, for both mid power and high power transceivers (only the flex changes depending on mid power or high power transceiver).

Figure 329: Transceiver Interface Board (TIB) Exploded View

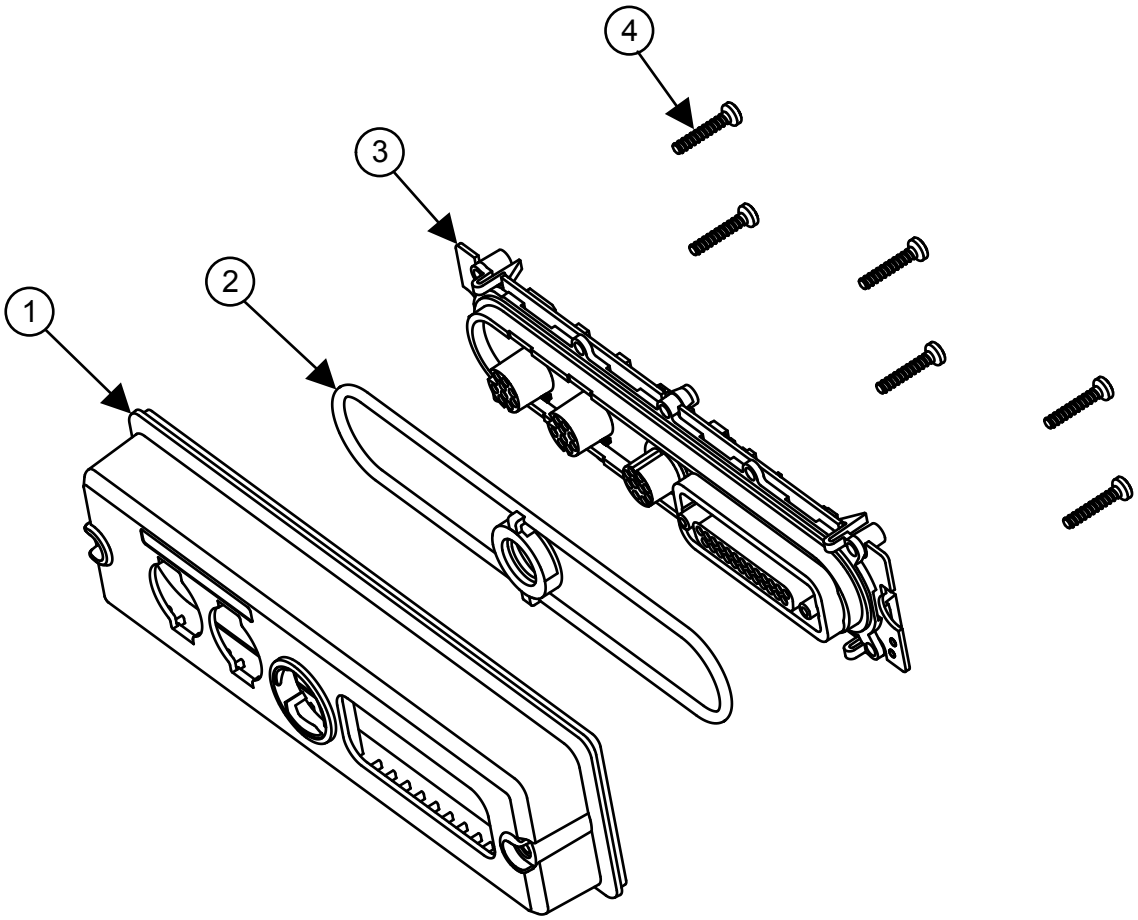


Table 91: Transceiver Interface Board (TIB) Parts List

Item No.	Motorola Solutions Part No.	Description
1	1575769B01 or 1575715B01	Housing, Mid Power Remote Front or Housing, High Power Remote Front
2	3264121H01	Seal, Moisture, Silicone
3	PHLN4000_	TIB Board Assembly

Item No.	Motorola Solutions Part No.	Description
4	0310909F21	Screw, Tapping (6)
*	3364474H01	Label, Housing (On Housing)
*	HLN6980_	Kit, Dust Cover (Not shown)

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

11.12

APX 2500/4500/4500Li/1500 O2 Dash Mount Radio Exploded View and Parts List

Figure 330: APX 2500/4500/4500Li/1500 O2 Dash Mount Radio Exploded View

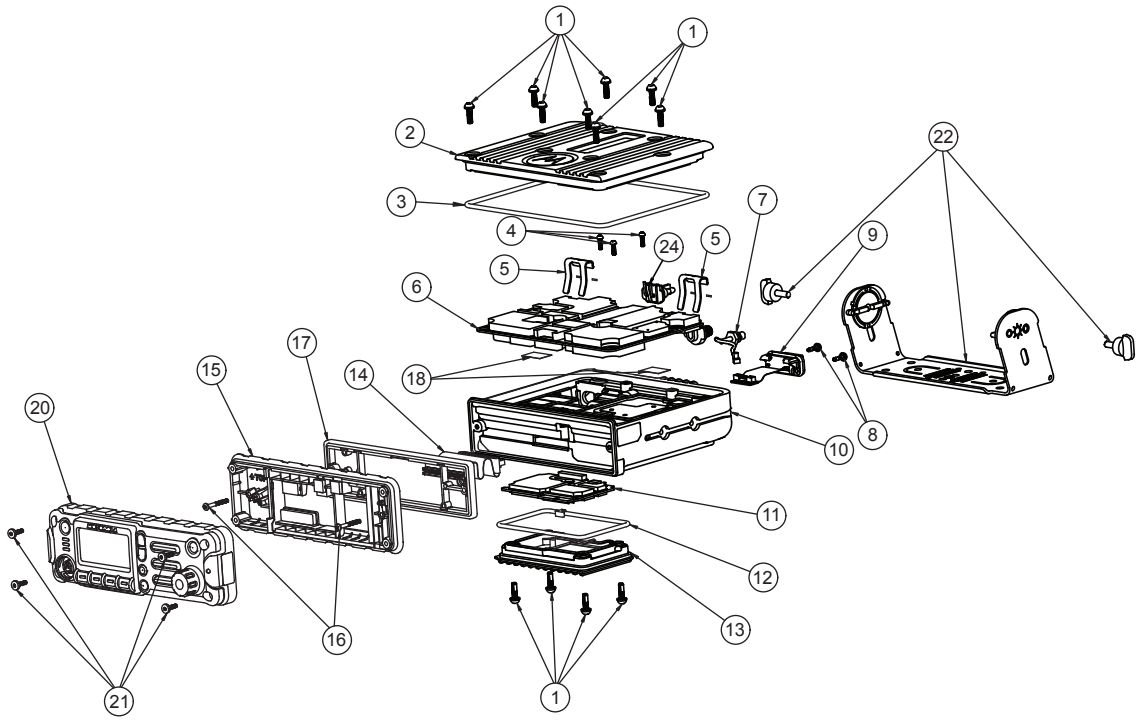


Table 92: APX 2500/4500/4500Li/1500 O2 Dash Mount Radio Parts List

Item No.	Motorola Solutions Part No.	Description
1	0104054J54	Assembly, Screw, Sealing
2	15012211001	Cover, Top
3	32012219001	Seal, Top Cover
4	0310909A33	Screw, Heat Spreader
5	4285702E01	Clip, RF and DC Connectors
6	See Table 103: Universal Relay Controller Parts List on page 381 for Kit Number	APX2500/4500/4500Li/1500 RF Board

Item No.	Motorola Solutions Part No.	Description
7	3015953H02	Cable, GPS
8	0371838H01	Screw, D-Sub for accessory connector
9	0104052J27	Flex Assembly, Accessory Connector
10	27012024002	Chassis, Main
11	See Table 105: APX 2500/4500/4500Li/1500 Low/Mid Power Controller Board on page 382 for Kit Number	APX2500/APX 4500/4500Li/1500 Controller Board
12	32012220001	Seal, Controller Cover
13	15012212001	Cover, Bottom
14	0104046J26	Dash Mount Flex Assembly
15	0104046J72	O2 Control Head Back Housing Assembly
16	03012052001	O2 Transceiver Screw
17	3264059H03	I-Seal
18	75012190001	Pad, Thermal
19	1110022D23	Compound, Thermal Joint
20	PMHN4193_ PMHN4195_	O2 Control Head (Grey) O2 Control Head (Green)
21	03012063001	O2 Housing Retention Screw (M4) with Washer & Screw
22	HLN6861_	Trunnion Installation Kit
23	–	FCC Label
24	09009344005	Connector DC Power

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

11.13

APX 2500 O3 Radio Exploded View and Parts List

Figure 331: APX 2500 O3 Radio Exploded View

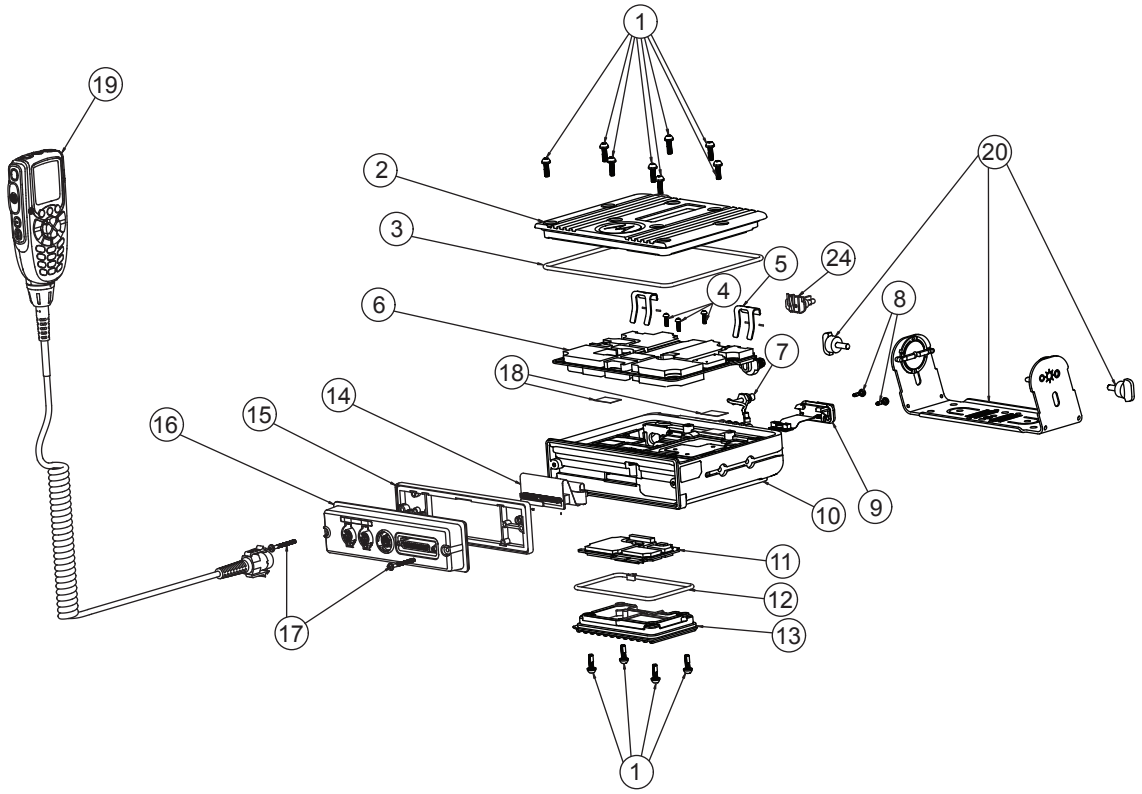


Table 93: APX 2500 O3 Radio Parts List

Item No.	Motorola Solutions Part No.	Description
1	0104054J54	Assembly, Screw, Sealing
2	15012211001	Cover, Top
3	32012219001	Seal, Top Cover
4	0310909A33	Screw, Heat Spreader
5	4285702E01	Clip, RF and DC Connectors
6	See Table 103: Universal Relay Controller Parts List on page 381 for Kit Number	APX 2500 RF Board
7	3015953H02	Cable, GPS
8	0371838H01	Screw, D-Sub for accessory connector
9	0104052J27	Flex Assembly, Accessory Connector
10	27012024002	Chassis, Main
11	See Table 105: APX 2500/4500/4500Li/1500 Low/Mid Power Controller Board on page 382 for Kit Number	APX 2500 Controller Board

Item No.	Motorola Solutions Part No.	Description
12	32012220001	Seal, Controller Cover
13	15012212001	Cover, Bottom
14	HKN6205_	TIB Flex Assembly
15	3264059H03	I-Seal
16	PMUN1058_	TIB Housing
17	0364332H02	TIB Screw
18	75012190001	Pad, Thermal
19	PMUN 1034_	O3 Control Head (English)
	PMUN1052_	O3 Control Head (Hebrew)
	PMUN1053_	O3 Control Head (Cyrillic)
	PMUN1054_	O3 Control Head (Arabic)
	PMUN4227_	O3 Control Head (Siren & Lights)
20	HLN6861_	Trunnion Installation Kit
21	1110022D23	Compound, Thermal Joint
23	–	FCC Label
24	09009344005	Connector DC Power

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

11.14

APX 2500 O7 Dash Mount Radio Exploded View and Parts List

Figure 332: APX 2500 O7 Dash Mount Radio Exploded View

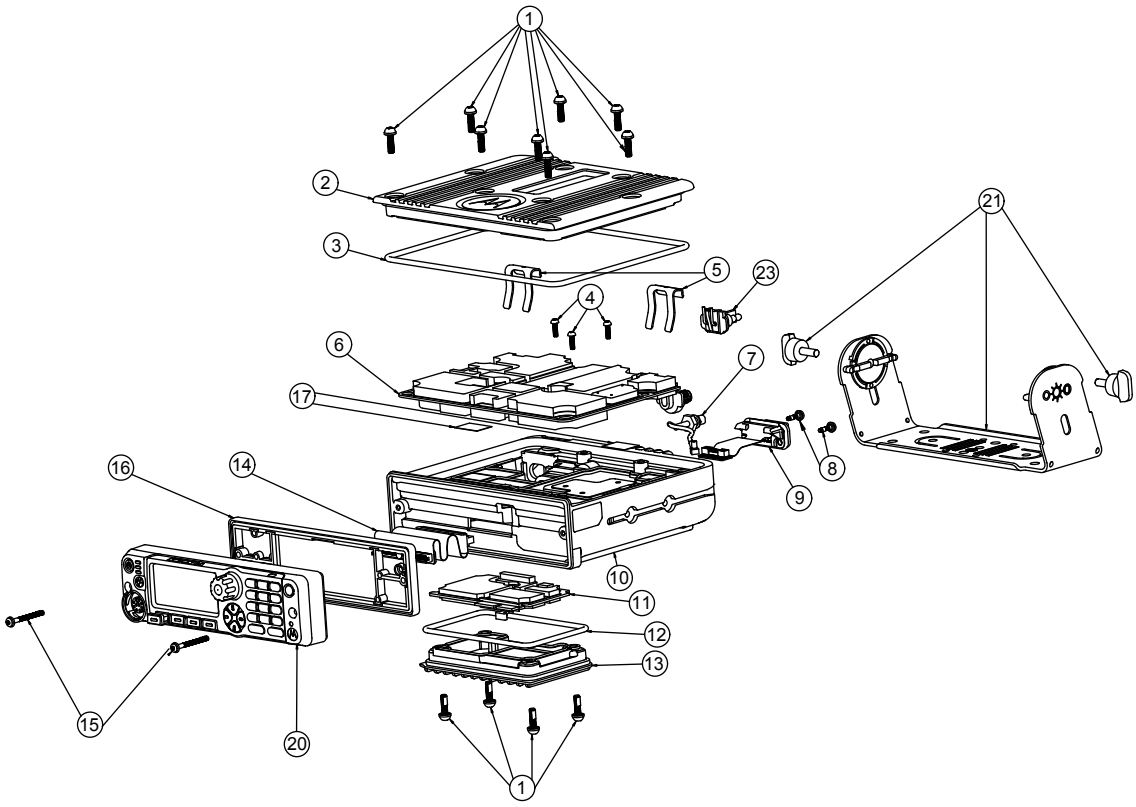


Table 94: APX 2500 O7 Dash Mount Radio Parts List

Item No.	Motorola Solutions Part No.	Description
1	0104054J54	Assembly, Screw, Sealing
2	15012211001	Cover, Top
3	32012219001	Seal, Top Cover
4	0310909A33	Screw, Heat Spreader
5	4285702E01	Clip, RF & DC Connectors
6	See Table 103: Universal Relay Controller Parts List on page 381 for Kit Number	APX 2500 RF Board
7	3015953H02	Cable, GPS
8	0371838H01	Screw, D-Sub for Accessory Connector
9	0104052J27	Flex Assembly, Accessory Connector
10	27012024002	Chassis, Main
11	See Table 105: APX 2500/4500/4500Li/1500 Low/Mid Power Controller Board on page 382 for Kit Number	APX 2500 Controller Board

Item No.	Motorola Solutions Part No.	Description
12	32012220001	Seal, Controller Cover
13	15012212001	Cover, Bottom
14	0104046J26	Dash Mount Flex Assembly
15	03012062001	O7 Transceiver Screw with Washer & Seal
16	3264059H03	I-Seal
17	75012190001	Pad, Thermal
19	1110022D23	Compound, Thermal Joint
20	PMHN4194_ PMHN4192_ PMHN4197_ PMHN4196_ PMHN4191_ PMHN4229_	O7 Control Head (English) O7 Control Head (English_Chinese) O7 Control Head (English_Cyrillic) O7 Control Head (English_Hebrew) O7 Control Head (Alt Keypad Graphics) O7 Control Head (English Arabic)
21	HLN6861_	Trunnion Installation Kit
22	–	FCC Label
23	09009344005	Connector DC Power

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

11.15

APX 5500/6500/7500/6500 Li O2 Dash Mount Radio Exploded View and Parts List

Figure 333: APX 5500/6500/7500/6500 Li O2 Dash Mount Radio Exploded View

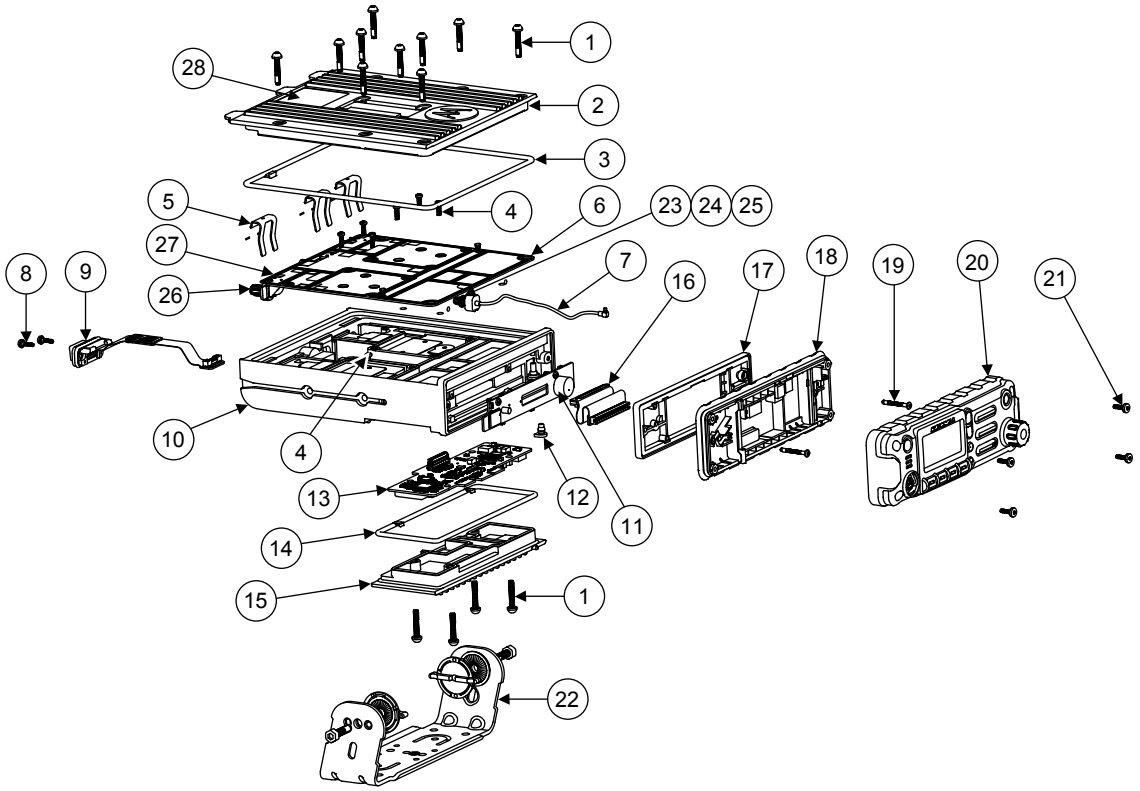


Table 95: APX 5500/6500/7500/6500 Li O2 Dash Mount Radio Parts List

Item No.	Motorola Solutions Part No.	Description
1	0385870E01	RF And Controller Cover Screws
2	1575713B02	Cover, Mid Power RF Main W/Choform
3	3275733B01	Seal, RF Cover (Mid Power[20])
4	0310909A33	Screw
5	4285702E01	Clip, RF/DC Conn
6	See Table 103: Universal Relay Controller Parts List on page 381 for Kit Number	Low/Mid Power RF Board[20]
7	3075725B01	Cable, GPS Coax Assembly (Mid Power[20])
8	0371838H01	Screw Assembly, Accessory Header
9	8475744B01	Flex Assembly, Accessory Connector
10	2775718B02	Chassis, Main (Mid Power[20]) W/Choform
11	MHLN6999_S	Option Board W/ 3 Day Retention

[20] Applies to APX 5500/APX 6500/APX 7500/APX 6500 Li

Item No.	Motorola Solutions Part No.	Description
	MHLN7000_S	Option Board For APX Mobiles[20]
12	3275737B01	Seal, Wlan Port Plug
13	PPHLN7036_	Controller Board[20]
14	3275732B01	Seal, Controller Cover (Mid Power[20])
15	1575714B02	Cover, Mid Power Controller W/Choform
16	0104046J26	Dash Mount Flex Assembly
17	3264059H03	I-Seal
18	0104046J72	O2 Back Housing Assembly
19	03012052001	Transceiver Screws
20	PMHN4193_ PMHN4195_	O2 Control Head Grey O2 Control Head Green
21	03012063001	Housing Retention Screws
22	HLN7002_	Mid Power Installation Kit
23	04009258001	Washers, GPS Internal Tooth[20]
24	32009266001	Seal, GPS[20]
25	02009258001	Nut, GPS[20]
26	3275731B01	Seal, RF Connector[20]
27	3285744E01	Seal, DC Connector
28	–	FCC Label

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

11.16

APX 5500/6500/7500/6500 Li O3 Radio Exploded View and Parts List

Figure 334: APX 5500/6500/7500/6500 Li O3 Radio Exploded View

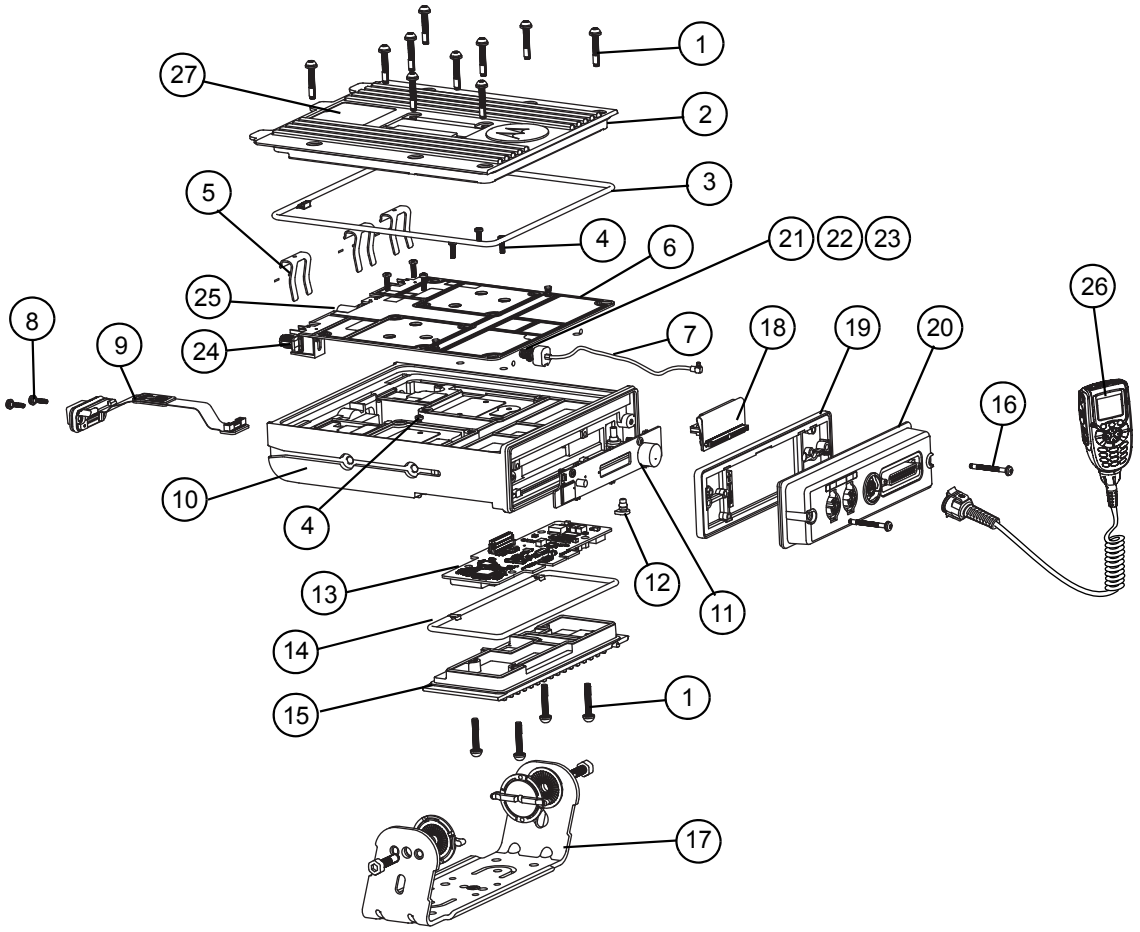


Table 96: APX 5500/6500/7500/6500 Li O3 Radio Parts List

Item No.	Motorola Solutions Part No.	Description
1	0385870E01	RF And Controller Cover Screws
2	1575713B02	Cover, Mid Power RF Main W/Choform
3	3275733B01	Seal, RF Cover (Mid Power[21])
4	0310909A33	Screw
5	4285702E01	Clip, RF/DC Conn
6	See Table 103: Universal Relay Controller Parts List on page 381 for Kit Number	[21]Low/Mid Power RF Board
7	3075725B01	Cable, GPS Coax Assembly (Mid Power[21])
8	0371838H01	Screw Assembly, Accessory Header

[21] Applies to APX 5500/APX 6500/APX 7500/APX 6500 Li

Item No.	Motorola Solutions Part No.	Description
9	8475744B01	Flex Assembly, Accessory Connector
10	2775718B02	Chassis, Main (Mid Power[21]) W/Choform
11	MHLN6999_S MHLN7000_S	Option Board W/ 3 Day Retention [21] Option Board For APX Mobiles
12	3275737B01	Seal, Wlan Port Plug
13	PPHLN7036_	Controller Board[21]
14	3275732B01	Seal, Controller Cover (Mid Power[21])
15	1575714B02	Cover, Mid Power Controller W/Choform
16	0364332H02	TIB Screws (TIB Housing To Chassis) Assembly
17	HLN7002_	Mid Power Installation Kit
18	HKN6205_	Remote Flex Kit
19	3264059H03	Seal, Frame, Mid Power Remote
20	PMUN1058_	Standard TIB Mp[21] (Mp Std TIB[21])
21	04009258001	Washers, GPS Internal Tooth[21]
22	32009266001	Seal, GPS[21]
23	02009258001	Nut, GPS[21]
24	3275731B01	Seal, RF Connector[21]
25	3285744E01	Seal, DC Connector
26	PMUN1034_ PMUN1052_ PMUN1053_ PMUN1054_ PMUN4227_	O3 Control Head (English) O3 Control Head (Hebrew) O3 Control Head (Cyrillic) O3 Control Head (Arabic) O3 Control Head (Siren & Lights)
27	–	FCC Label

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

11.17

APX 5500/6500/7500/6500 Li O5 Dash Mount Radio Exploded View and Parts List

Figure 335: APX 5500/6500/7500/6500 Li O5 Dash Mount Radio Exploded View

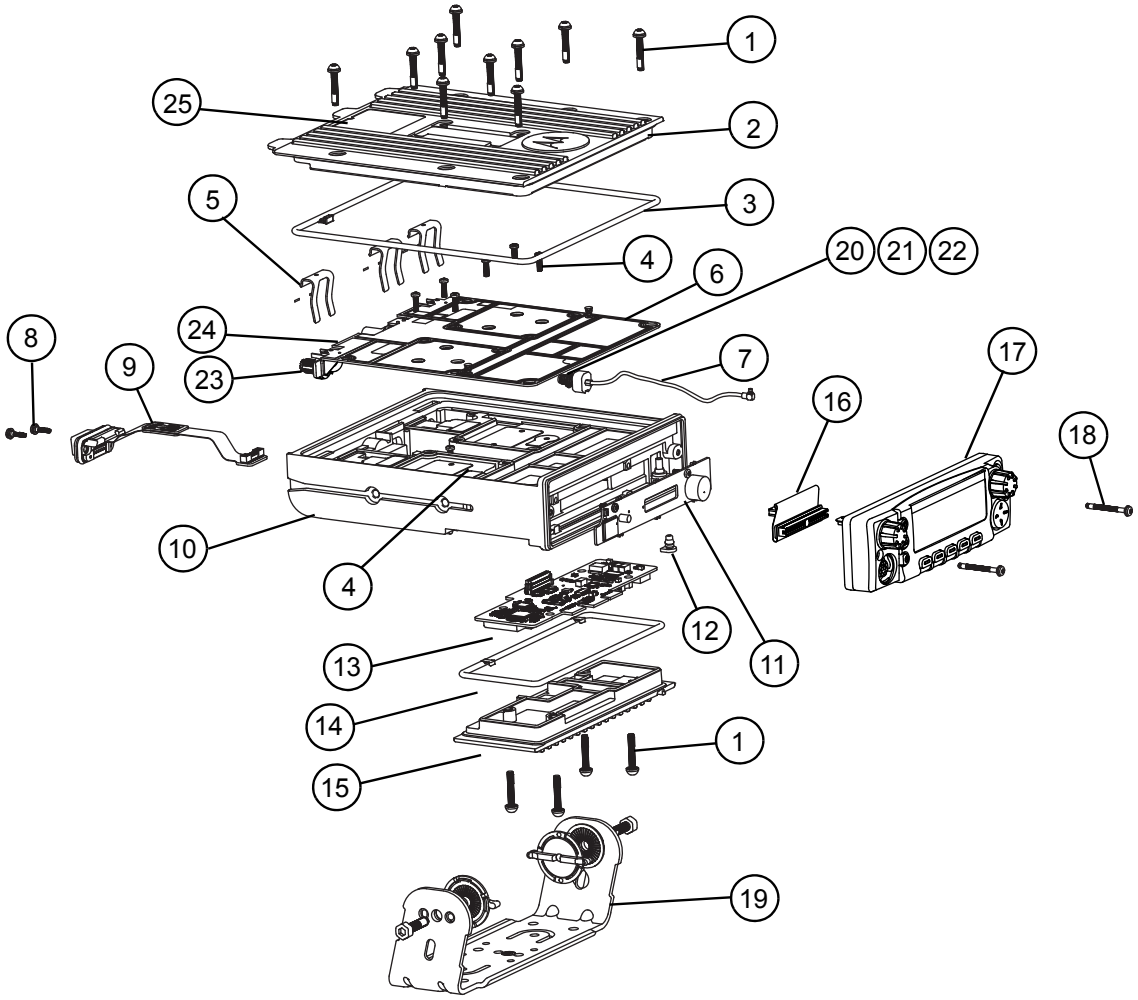


Table 97: APX 5500/6500/7500/6500 Li O5 Dash Mount Radio Parts List

Item No.	Motorola Solutions Part No.	Description
1	0385870E01	RF And Controller Cover Screws
2	1575713B02	Cover, Mid Power RF Main W/Choform
3	3275733B01	Seal, RF Cover (Mid Power[22])
4	0310909A33	Screw
5	4285702E01	Clip, RF/DC Conn
6	See Table 103: Universal Relay Controller Parts List on page 381 for Kit Number	[22]Low/Mid Power RF Board

[22] Applies to APX 5500/6500/7500/6500 Li

Item No.	Motorola Solutions Part No.	Description
7	3075725B01	Cable, GPS Coax Assembly (Mid Power[22])
8	0371838H01	Screw Assembly, Accessory Header
9	8475744B01	Flex Assembly, Accessory Connector
10	2775718B02	Chassis, Main (Mid Power[22]) W/Choform
11	MHLN6999_S MHLN7000_S	Option Board W/ 3 Day Retention Option Board For APX Mobiles[22]
12	3275737B01	Seal, Wlan Port Plug
13	PPHLN7036_	Controller Board[22]
14	3275732B01	Seal, Controller Cover (Mid Power[22])
15	1575714B02	Cover, Mid Power Controller W/Choform
16	HKN6206_	Dash Flex Kit
17	PHCN4000_	O5 Control Head
18	0364332H02	TIB Screws (TIB Housing To Chassis) Assembly
19	HLN7002_	Mid Power Installation Kit
20	04009258001	Washers, GPS Internal Tooth[22]
21	32009266001	Seal, GPS[22]
22	02009258001	Nut, GPS[22]
23	3275731B01	Seal, RF Connector[22]
24	3285744E01	Seal, DC Connector
25	–	FCC Label

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

11.18

APX 5500/6500/7500/6500 Li E5 Dash Mount Radio Exploded View and Parts List

Figure 336: APX 5500/6500/7500/6500 Li E5 Dash Mount Radio Exploded View

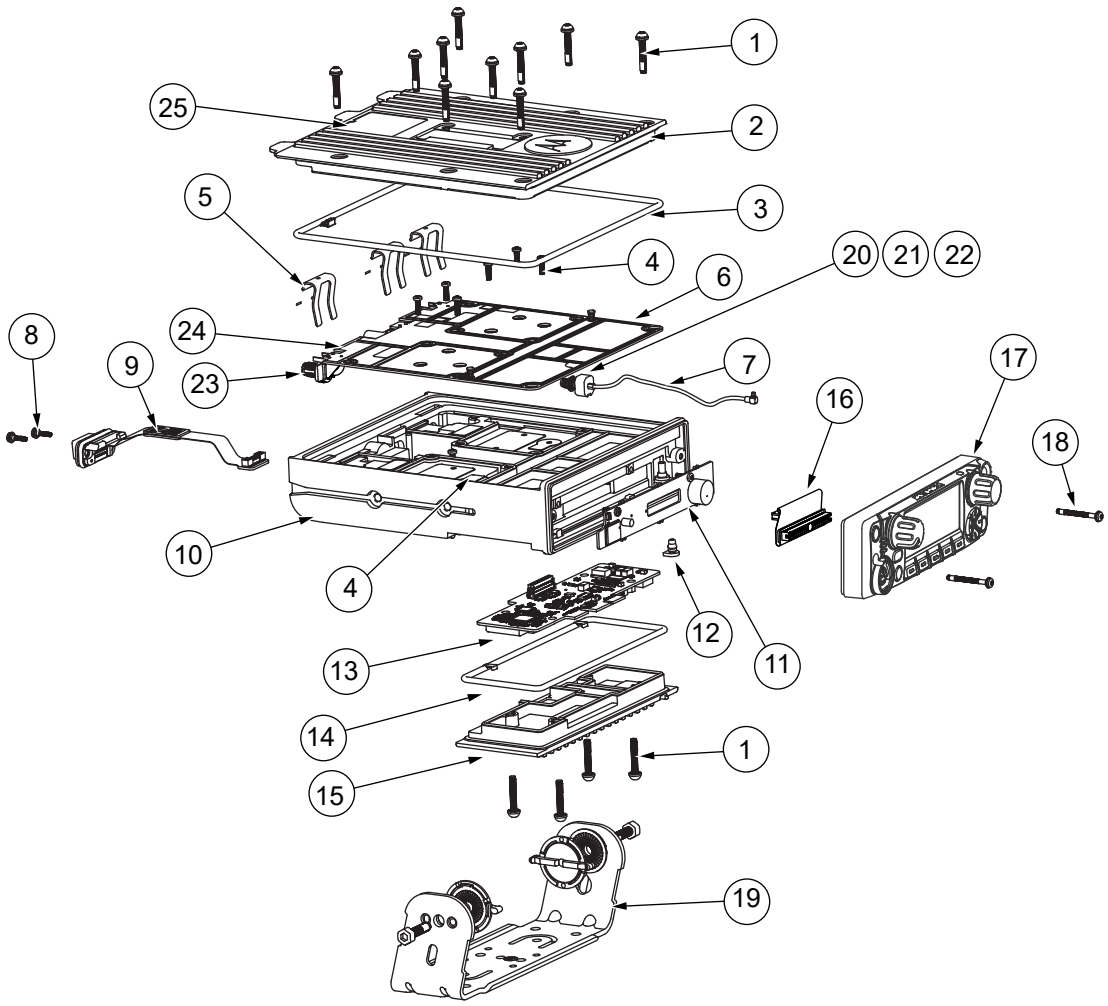


Table 98: APX 5500/6500/7500/6500 Li E5 Dash Mount Radio Parts List

Item No.	Motorola Solutions Part No.	Description
1	0385870E01	RF And Controller Cover Screws
2	1575713B02	Cover, Mid Power RF Main W/Choform
3	3275733B01	Seal, RF Cover (Mid Power[23])
4	0310909A33	Screw
5	4285702E01	Clip, RF/DC Conn

[23] Applies to APX 5500/6500/7500/6500 Li

Item No.	Motorola Solutions Part No.	Description
6	See Table 103: Universal Relay Controller Parts List on page 381 for Kit Number	[22]Low/Mid Power RF Board
7	3075725B01	Cable, GPS Coax Assembly (Mid Power[22])
8	0371838H01	Screw Assembly, Accessory Header
9	8475744B01	Flex Assembly, Accessory Connector
10	2775718B02	Chassis, Main (Mid Power[22]) W/Choform
11	MHLN6999_S MHLN7000_S	Option Board W/ 3 Day Retention Option Board For APX Mobiles[22]
12	3275737B01	Seal, Wlan Port Plug
13	PPHLN7036_	Controller Board[22]
14	3275732B01	Seal, Controller Cover (Mid Power[22])
15	1575714B02	Cover, Mid Power Controller W/Choform
16	HKN6206_	Dash Flex Kit
17	PHCN4001_	E5 Control Head
18	03012062002	Transceiver Screw
19	HLN7002_	Mid Power Installation Kit
20	04009258001	Washers, GPS Internal Tooth[22]
21	32009266001	Seal, GPS[22]
22	02009258001	Nut, GPS[22]
23	3275731B01	Seal, RF Connector[22]
24	3285744E01	Seal, DC Connector
25	–	FCC Label

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

11.19

APX 2500/4500 O5 Dash Mount Radio Exploded View and Parts List

Figure 337: APX 2500/4500 O5 Dash Mount Radio Exploded View

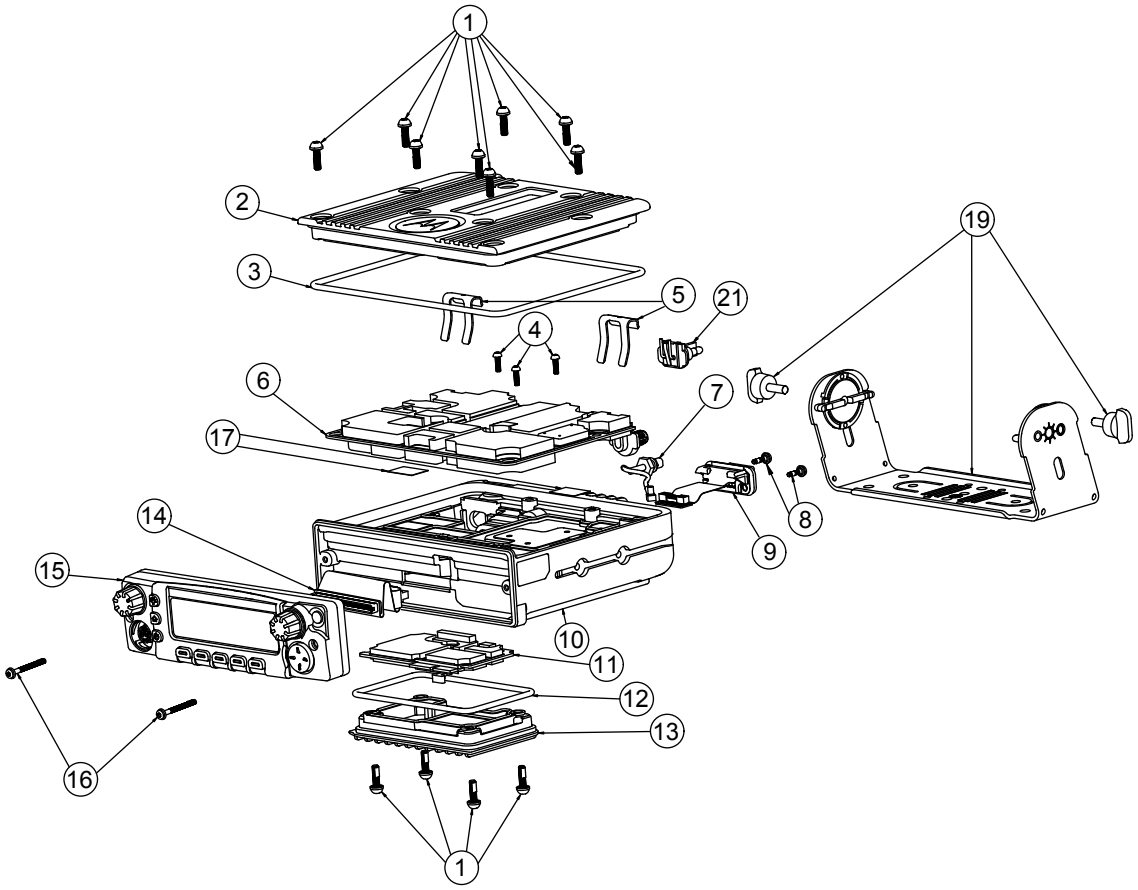


Table 99: APX 2500/4500 O5 Dash Mount Radio Parts List

Item No.	Motorola Solutions Part No.	Description
1	0104054J54	Assembly, Screw, Sealing
2	15012211001	Cover, Top
3	32012219001	Seal, Top Cover
4	0310909A33	Screw, Heat Spreader
5	4285702E01	Clip, RF & DC Connectors
6	See Table 103: Universal Relay Controller Parts List on page 381 for Kit Number	APX 2500/4500 RF Board
7	3015953H02	Cable, GPS
8	0371838H01	Screw, D-Sub for Accessory Connector
9	0104052J27	Flex Assembly, Accessory Connector
10	27012024002	Chassis, Main

Item No.	Motorola Solutions Part No.	Description
11	See Table 105: APX 2500/4500/4500Li/1500 Low/Mid Power Controller Board on page 382 for Kit Number	APX 2500/4500 Controller Board
12	32012220001	Seal, Controller Cover
13	15012212001	Cover, Bottom
14	HKN6206_	Dash Flex Kit
15	PHCN4000_	O5 Control Head
16	0364332H02	TIB Screws (TIB Housing To Chassis) Assembly
17	75012190001	Pad, Thermal
18	1110022D23	Compound, Thermal Joint
19	HLN6861_	Trunnion Installation Kit
20	–	FCC Label
21	09009344005	Connector DC Power

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

11.20

APX 2500/4500 E5 Dash Mount Radio Exploded View and Parts List

Figure 338: APX 2500/4500 E5 Dash Mount Radio Exploded View

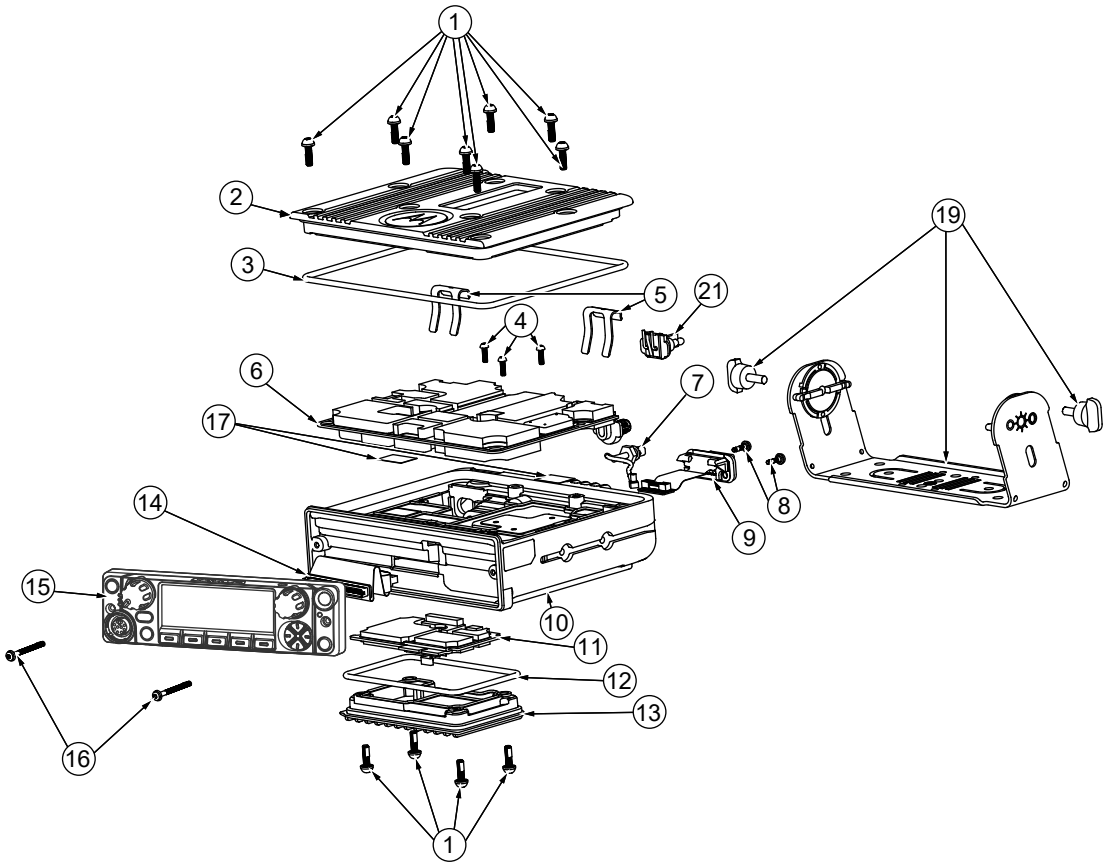


Table 100: APX 2500/4500 E5 Dash Mount Radio Parts List

Item No.	Motorola Solutions Part No.	Description
1	0104054J54	Assembly, Screw, Sealing
2	15012211001	Cover, Top
3	32012219001	Seal, Top Cover
4	0310909A33	Screw, Heat Spreader
5	4285702E01	Clip, RF & DC Connectors
6	See Table 103: Universal Relay Controller Parts List on page 381 for Kit Number	APX 2500/4500 RF Board
7	3015953H02	Cable, GPS
8	0371838H01	Screw, D-Sub for Accessory Connector
9	0104052J27	Flex Assembly, Accessory Connector
10	27012024002	Chassis, Main

Item No.	Motorola Solutions Part No.	Description
11	See Table 105: APX 2500/4500/4500Li/1500 Low/Mid Power Controller Board on page 382 for Kit Number	APX 2500/4500 Controller Board
12	32012220001	Seal, Controller Cover
13	15012212001	Cover, Bottom
14	HKN6206_	Dash Flex Kit
15	PHCN4001_	E5 Control Head
16	03012062002	Transceiver Screw
17	75012190001	Pad, Thermal
18	1110022D23	Compound, Thermal Joint
19	HLN6861_	Trunnion Installation Kit
20	–	FCC Label
21	09009344005	Connector DC Power

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

11.21

APX 5500/6500/7500/6500 Li O7 Dash Mount Radio Exploded View and Parts List

Figure 339: APX 5500/6500/7500/6500 Li O7 Dash Mount Radio Exploded View

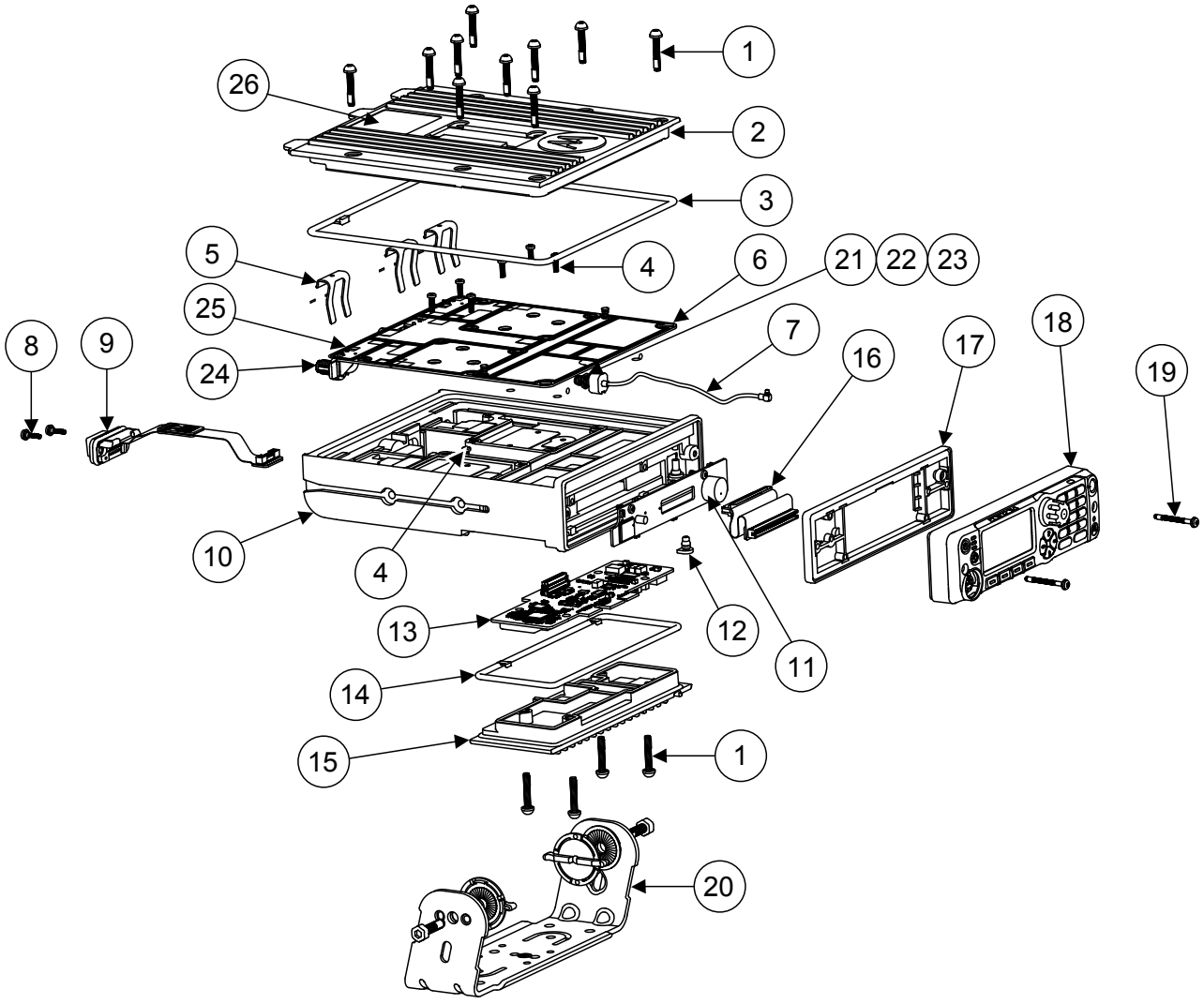


Table 101: APX 5500/6500/7500/6500 Li O7 Dash Mount Radio Parts List

Item No.	Motorola Solutions Part No.	Description
1	0385870E01	RF And Controller Cover Screws
2	1575713B02	Cover, Mid Power RF Main W/Choform
3	3275733B01	Seal, RF Cover (Mid Power[24])
4	0310909A33	Screw
5	4285702E01	Clip, RF/DC Conn

[24] Applies to APX 5500/6500/7500/6500 Li

Item No.	Motorola Solutions Part No.	Description
6	See Table 103: Universal Relay Controller Parts List on page 381 for Kit Number	[24]Low/Mid Power RF Board
7	3075725B01	Cable, GPS Coax Assembly (Mid Power[24])
8	0371838H01	Screw Assembly, Accessory Header
9	8475744B01	Flex Assembly, Accessory Connector
10	2775718B02	Chassis, Main (Mid Power[24]) W/Choform
11	MHLN6999_S MHLN7000_S	Option Board W/ 3 Day Retention Option Board For APX Mobiles[24]
12	3275737B01	Seal, Wlan Port Plug
13	PPHLN7036_	Controller Board[24]
14	3275732B01	Seal, Controller Cover (Mid Power[24])
15	1575714B02	Cover, Mid Power Controller W/Choform
16	0104046J26	Dash Mount Flex Assembly
17	3264059H03	I-seal
18	PMHN4194_ PMHN4192_ PMHN4197_ PMHN4196_ PMHN4191_ PMHN4229_	O7 Control Head English O7 Control Head English_Chinese O7 Control Head English_Cyrillic O7 Control Head English_Hebrew O7 Control Head Siren and Light O7 Control Head English Arabic
19	03012062001	Transceiver Screws
20	HLN7002_	Mid Power Installation Kit
21	04009258001	Washers, GPS Internal Tooth[24]
22	32009266001	Seal, GPS[24]
23	02009258001	Nut, GPS[24]
24	3275731B01	Seal, RF Connector[24]
25	3285744E01	Seal, DC Connector
26	–	FCC Label

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

11.22

APX 5500/6500/7500/6500 Li 100 W Remote Mount Radio Exploded View and Parts List

Figure 340: APX 5500/6500/7500/6500 Li 100 W Remote Mount Radio Exploded View

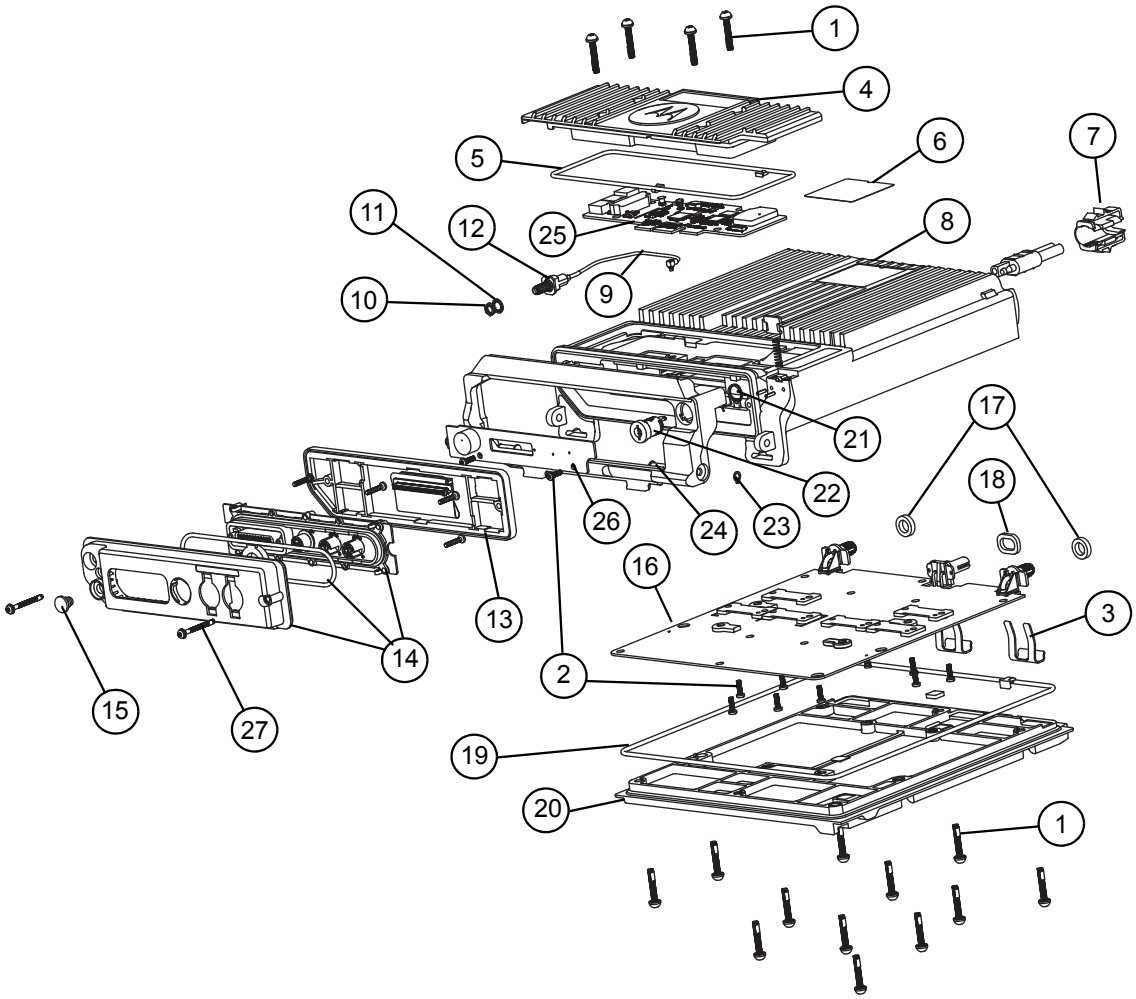


Table 102: APX 5500/6500/7500/6500 Li 100 W Remote Mount Radio Parts List

Item No.	Motorola Solutions Part No.	Description
1	0385870E01	RF And Controller Cover Screws
2	0310909A33	Screw
3	4285702E01	Clip, RF/DC Conn
4	1575712B02	Cover, High Power Controller W/Choform
5	3275734B01	Seal, Controller Cover (HP[25])
6	-	FCC Label
7	HLN7017_	Sleeve, HP[25] DC Connector

[25] Applies to APX 5500/6500/7500/6500 Li

Item No.	Motorola Solutions Part No.	Description
8	0180706K42	Chassis, Main (HP[25]) W/Choform Sub-Assembly
9	3075723B01	Cable, GPS Coax Assembly (HP[25])
10	02009258001	Nut, GPS[25]
11	04009258001	Washers, GPS[25] Internal Tooth
12	32009266001	Seal, GPS[25]
13	3271902H01	High Power I-Seal
14	PMUN1040_	Standard TIB HP[25]
15	3875115H01	Seal, High Power WLAN Port Plug
16	See Table 104: APX 5500/6500/7500/6500 Li 100 W Power RF Board on page 382 for Kit Number	100 W Power RF Board[25]
17	3275731B01	Seal, RF Connector[25]
18	3285744E01	Seal, DC Connector
19	3275735B01	Seal, RF Cover (HP[25])
20	1575711B02	Cover, High Power RF Main W/Choform
21	4171865H01	Spring, Torque (For Lock)
22	5571649H01	Lock Assembly
23	4271651H01	Clip For Handle Pin
24	2271650H01	Pivot Pin, For Handle
25	PPHLN7036_	Controller Board[25]
26	HLN6999_ HLN7000_	Option Board W/ 3 Day Retention Option Board For APX Mobile[25]
27	0364332H02	TIB Screws (TIB Housing To Chassis) Assembly
*	HLN7003_	Trunnion Mouting Kit

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

11.23

Universal Relay Controller Exploded View and Parts List

Figure 341: Universal Relay Controller Exploded View

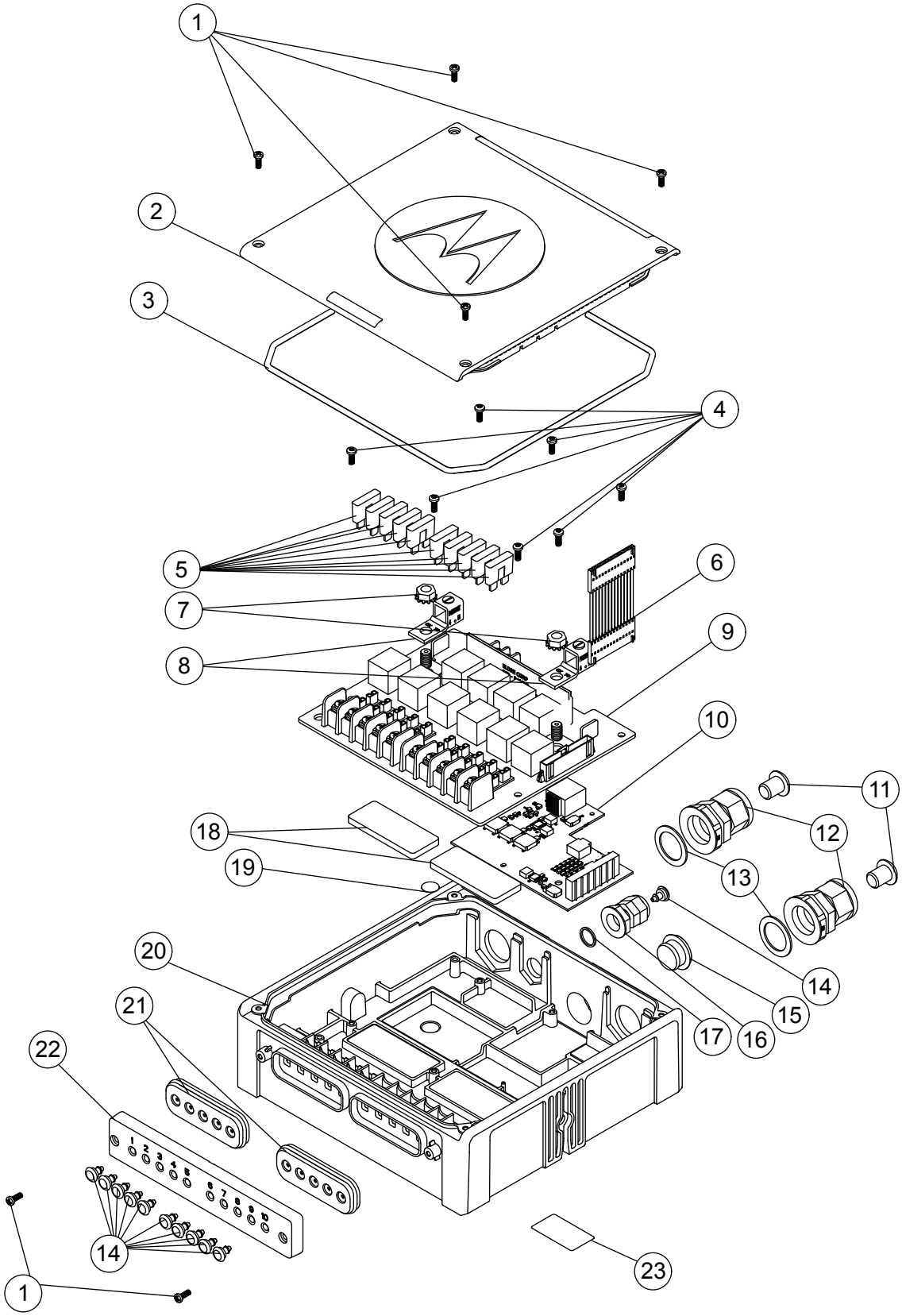


Table 103: Universal Relay Controller Parts List

Item No.	Motorola Solutions Part No.	Description
1	0371889L03	M3X8MM, Machined Phillips Screw, EDBK
2	1578387A01	Top Housing
3	3275880M01	Main O-Ring
4	03012023001	M3X8MM, Machined TORX Screw
5	6500139768	Fuse
6	0975931M01	Connector Wire Harness
7	0275935M01	Nut, PCB Stud
8	3975932M01	Power Lug
9	PMLN5639_	URC Relay PCB Kit
10	PMLN5640_	URC Relay PCB Kit
11	32012001001	Seal, Power Cable Gland
12	42007054001	Power Cable Gland Assembly
13	32012036002	Gasket, Cable Gland (Power)
14	32012002001	Seal, Gasket and Ground Cable Gland
15	32012030001	Seal, RJ 45
16	42007054002	Ground Cable Gland Assembly
17	32012036001	Gasket, Cable Gland (Ground)
18	75012026001	Pad, Thermal, Hub Main Chassis
19	3278443A01	Seal, Port
20	27012007001	Chassis, Main, O9 Hub
21	3278310A01	Light Bar Gasket
22	4278307A01	Light Bar Gasket Retainer
23	54012001001	Label, Serial

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

APX 5500/6500/7500/6500 Li/2500/4500/4500Li/1500 Low/Mid Power RF Board

Motorola Solutions Part No.	Description
HUF4022_Z	700–800 MID POWER RF BOARD[26]
HUD4026_Z	VHF MID POWER RF BOARD[26]
HUR4001_Z	APX 7500 700–800/VHF MID POWER RF BOARD
HUT4001_Z	APX 7500 VHF/UHF RANGE 1 MID POWER RF BOARD
HUE4044_Z	UHF RANGE 1 MID POWER RF BOARD[26]
HUS4002_Z	APX 7500 UHF RANGE 1 700–800 MID POWER RF BOARD

[26] Applies to APX 5500/APX 6500/APX 7500/APX 6500 Li

Motorola Solutions Part No.	Description
MHUE4001_S	UHF RANGE 2 MID POWER RF BOARD[26]
HUS4001_Z	APX 7500 UHF RANGE 2 700–800 MID POWER RF BOARD
PMLF4092_S	APX 2500/4500/4500Li/1500 700–800 RF Board
PMLD4554_S	APX 2500/4500/4500Li/1500 VHF RF Board
PMLE4806_S	APX 2500/4500/4500Li/1500 UHF R1 RF Board
PMLE4924_S	APX 2500/4500/4500Li/1500 UHF R2 RF Board
PMLF4118_S	APX 4500 900 RF Board

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

Table 104: APX 5500/6500/7500/6500 Li 100 W Power RF Board

Motorola Solutions Part No.	Description
HUD4027_Z	VHF HIGH POWER RF BOARD[26]
HUE4045_Z	UHF Range 1 High Power RF Board[26]
HUR4000_Z	APX 7500 VHF High/ 700–800 Mid Power RF Board
MHUT4000_S	APX 7500 VHF HIGH/UHF RANGE 1 HIGH POWER RF BOARD

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

Table 105: APX 2500/4500/4500Li/1500 Low/Mid Power Controller Board

Motorola Solutions Part No.	Description
PMLN6299_S	APX 2500/4500/4500Li/1500 Controller Service Kit without Secure
PMLN6176_S	APX 2500/APX 4500 Controller Service Kit with Secure (Refer to Table 61: Controller Boards with Programmed Secure Algorithms for APX 2500 on page 159 and Table 62: Controller Boards with Programmed Secure Algorithms for APX 4500 on page 160 for secure algorithm details.)

NOTE: The underscore (_) used at the end of the kit number is replaced with the kit revision letter. When ordering, refer to your specific kit for this suffix letter.

Appendix A

Accessories

Motorola Solutions provides various approved optional accessories to improve the performance of your radio.

Refer to the specific radio price pages for a list of FCC-certified and/or Motorola Solutions-approved accessories. You can also contact your sales representative for accessory compatibility.

For more information, visit http://www.motorolasolutions.com.

Appendix B

Replacement Parts and Kits

This manual covers Level 1 and 2 Maintenance.

Level 1 maintenance is the assessment and/or repair of fault in terms of a faulty accessory or physical aspect of product; not including disassembly of the unit. It is limited to the replacement of antenna, battery, handset, external microphones, external knobs, all related frequency programming to customers, and sometimes alignment or tuning by the Customer Programming Software (CPS).

Level 2 maintenance includes all Level 1 activities plus assessment that require the disassembly of the radio and rectifying a fault by replacement of major mechanical parts (such as replacement of bezels).

Level 2 maintenance does not incorporate discrete component replacement.

To find out more about Motorola Solutions Service Center, visit http://www.motorolasolutions.com.

NOTE: Only Motorola Solutions Service Center/Depot can perform Level 3 maintenance as it can deeply affect the performance of the radio.

Appendix C

Replacement Parts Ordering

Basic Ordering Information

When ordering replacement parts or equipment information, the complete identification number should be included. This applies to all components, kits, and chassis. If the component part number is not known, the order should include the number of the chassis or kit of which it is a part, and sufficient description of the desired component to identify it.

The ASTRO APX Mobile Radio Basic Service Manual includes complete parts lists and part numbers.

Refer to Table of Content for applicable manual numbers.

Motorola Solutions Service and Support

For general support, users can access:

- Motorola Solutions Products and Services Support
- Contact Motorola Solutions

To register for online access:

- Domestic customers: please call 800-814-0601 (U.S. and Canada).
- PCAT (Product Catalog)

Accessories Aftermarket Division (AAD)

The Accessories Aftermarket Division (AAD) is able to provide Motorola Solutions Branded accessories for all your radio needs. After you have a KIT number from the Motorola Solutions website, contact Motorola Solutions at: 1-888-325-9336.

Motorola Solutions provides the following approved optional accessories to improve the productivity of the APX Mobile Radios.

For a complete list of Motorola Solutions-approved antennas, cables, and other accessories, visit the following web site: APX Series P25 Two-Way Radios

On the website, search for APX Mobile Radios and you will see the accessories information beside the specifications of the radio. You can also contact your dealer for more details.

Appendix D

Motorola Solutions Service Centers

For more information regarding to your radio, please contact the following Motorola Solutions Service Centers to submit your queries.

Table 106: North America Motorola Solutions Offices

Office	Address	Telephone Number
Motorola Solutions Service Center	1220 Don Haskins Drive, Suite A El Paso, TX 79936	1-800-422-4210
Motorola Solutions Federal Technical Center	10105 Senate Drive Lanham, MD 20706	1-800-969-6680
		Fax: 1-800-784-4113
Motorola Solutions Canadian Technical Logistics Center	41 Bentley Street Markham, Ontario L3R 3L1	416-997-2410

Table 107: Latin America Motorola Solutions Offices

Office	Address	Telephone Number
Motorola Solutions de Mexico, S.A.	Bosques de Alisos 58 Col. Bosques de las Lomas C.P. 05120 México D.F. México	+52-55-5257-6700
Motorola Solutions de Colombia, Ltd	Carrera 98 No. 25G-64 of 108 Centro El Dorado, Bogota, Colombia,C.P. 110911	+57-1-508-90-00
Motorola Solutions Brazil, Ltd	Avenida Magalhães de Castro, 4800 Cidade Jardim Corporate Center Torre 3, 8º andar, 05676-120	0800-0552277 0800-0168272 0800-8924264

Appendix E

Warranty, Service, and Technical Support

Warranty and Service Support

Motorola Solutions offers long-term support for its products. This support includes full exchange and/or repair of the product during the warranty period and service/repair or spare parts support out of warranty. Any "return for exchange" or "return for repair" by an authorized Motorola Solutions Dealer must be accompanied by a Warranty Claim Form. Warranty Claim Forms are obtained by contacting an Authorized Motorola Solutions Dealer.

Warranty Period and Return Instructions

The terms and conditions of warranty are defined fully in the Motorola Solutions Dealer or Distributor or Reseller contract. These conditions may change from time to time and the following notes are for guidance purposes only.

In instances where the product is covered under a "return for replacement" or "return for repair" warranty, a check of the product should be performed before you ship the unit back to Motorola Solutions. This is to ensure that the product has been correctly programmed or has not been subjected to damage outside the terms of the warranty.

Before shipping any radio back to the appropriate Motorola Solutions warranty depot, contact Customer Resources. All returns must be accompanied by a Warranty Claim Form, available from your Customer Services representative. Products should be shipped back in the original packaging, or correctly packaged to ensure that no damage occurs in transit.

After Warranty Period

After the Warranty period, Motorola Solutions continues to support its products in two ways:

- Motorola Solutions Managed Technical Services (MTS) offers a repair service to both end users and dealers at competitive prices.
- MTS supplies individual parts and modules that can be purchased by dealers who are technically capable of performing fault analysis and repair.

Further Assistance

You can also contact the Customer Help Desk through http://www.motorolasolutions.com.

E.1
Service Information

Technical & Repair Support (for Contracted Customers Only)

If you would like to contact the Motorola Solutions Customer Care team, use the appropriate contact details below. Please be prepared to provide your contract number, product serial numbers, and detailed issue description for a faster response and a resolution. If the support request is Technical Support related, the request will be handled by the Technical Support Operations (TSO) team. This team of highly skilled professionals provides Technical Support to help resolve technical issues and quickly restore networks and systems. If you are unsure whether your current service agreement entitles you to benefit from this service, or if you would like more information about the Technical

or Repair Support Services, contact your local customer support or account manager for further information.

Contact Details

Technical Requests: techsupport.emea@motorolasolutions.com

Repair Support: repair.emea@motorolasolutions.com

Contact Us: https://www.motorolasolutions.com/en_xu/support.html

Parts Identification and Ordering

If you need help with identifying non-referenced spare parts, direct a request to the Customer Care Organization of a local area Motorola Solutions representative. Orders for replacement parts, kits, and assemblies should be placed directly at the local distribution organization of Motorola Solutions.

E.2

Service Information for APAC

This topic contains contact details to service centers in Asia and Pacific region.

Technical Support

Technical support is available to assist the dealer/distributor in resolving any malfunction which may be encountered. Initial contact should be by telephone wherever possible. When contacting Motorola Solutions Technical Support, be prepared to provide the product model number and the serial number.

Further Assistance from Motorola Solutions

You can also contact the Customer Help Desk through the website: http://www.motorolasolutions.com/en_xp/products. If a unit requires further complete testing, knowledge and/or details of component level troubleshooting or service than is customarily performed at the basic level, send the radio to a Motorola Solutions Service Center as listed in the following table:

Table 108: Service Information – Telephone Numbers and Addresses of the Asia and Pacific Motorola Solutions Centers

Country	Telephone Number	Address
Singapore	+65-6352-6383	**Motorola Solutions Singapore Pte. Ltd,** c/o Azure Engineering, 49 Jalan Pemimpin, #03-11 APS Industrial Building, Singapore 577203 Contact: Alvin Tan E-mail: alvin.tan@motorolasolutions.com Contact: Gan Saw See E-mail: gan.sawsee@motorolasolutions.com
Malaysia	+603-7809-0000	**Motorola Solutions Sdn. Bhd.** Level 14, Persoft Tower, No. 68, Pesiaran Tropicana, 47410 Petaling Jaya, Selangor Darul Ehsan, Malaysia

Country	Telephone Number	Address
		Contact: Koh Tiong Eng E-mail: A21001@motorolasolutions.com
Indonesia	+62-21-3043-5239	**PT. Motorola Solutions Indonesia** 30th Floor, Gedung BRI II, Suite 3001, Jl. Jend. Sudirman Kav. 44-46, Jakarta 10210, Indonesia Contact: Eko Haryanto E-mail: Eko.Haryanto@motorolasolutions.com
Thailand	Tel: +662-653-220 Fax: +668-254-5922	**Motorola Solutions (Thailand) Ltd.** 142 Two Pacific Place Suite 2201, 3220 Sukhumvit Road, Klongtoey, Bangkok 10110 Contact: Nitas Vatanasupapon E-mail: Nitas@motorolasolutions.com
India	+91-9844218850	**Motorola Solutions India Pvt. Ltd.** C/o Communication Test Design India Private Limited, #4, 5 Maruthi Industrial Estate, Rajapalya, Hoodi Village, Bangalore - 560048, India Contact: K. Umamaheswari E-mail: umamaheshwari@motorolasolutions.com
China	+86-10-8473-5128	**Motorola Solutions (China) Co. Ltd.** No. 1 Wang Jing East Road, Chao Yang District, Beijing, 100102, P.R. China Contact: Sophy Wang E-mail: C18170@motorolasolutions.com
Hong Kong	852-2966-4823	**Motorola Solutions Asia Pacific Ltd.** Unit 1807-1812, 18/F, Two Harbourfront, 22 Tak Fung Street, Hunghom, Kowloon, Hong Kong Contact: Judy Leung E-mail: Judy.Leung@motorolasolutions.com
Philippines	Tel: +632 858-7500 Fax: +632 841-0681	**Motorola Communications Philippines, Inc.** Unit 2102, One Global Place Building, 5th Ave., Bonifacio Global City, Taguig, Philippines 1634. Contact: Arthur Nieves E-mail: Arthur.Nieves@motorolasolutions.com

Country	Telephone Number	Address
Korea	+822-3497-3649	**Motorola Solutions Korea, Inc.** 9th Floor, Hibrand Building, 215, Yangjae-Dong, Seocho-Gu, Seoul, 137-924, Korea. Contact: KS Kwak E-mail: r45321@motorolasolutions.com
Taiwan	+886-2-8729 8000	**Motorola Solutions Taiwan, Ltd.** 8F, No. 9, Songgao Rd., Taipei 110, Taiwan (R.O.C.) Contact: Michael Chou E-mail: ftpe239@motorolasolutions.com
Australia	+613-9847-7725	**Motorola Solutions Australia Pty. Ltd.** 10 Wesley Court, Tally Ho Business Park, East Burwood Victoria 3151, Australia. E-mail: servicecentre.au@motorolasolutions.com

Piece Parts

Some replacement parts, spare parts, and/or product information can be ordered directly. If a complete Motorola Solutions part number is assigned to the part, it is available from Motorola Solutions Service Organization. If no part number is assigned, the part is not normally available from Motorola Solutions. If a list of parts is not included, that means that no user-serviceable parts are available for that kit or assembly.

Customer Programming Software has no capability to tune the radio. Tuning the radio can only be performed at the factory or at the appropriate Motorola Solutions Repair Center. Component replacement can affect the radio tuning and must only be performed by the appropriate Motorola Solutions Repair Center.

All orders for parts/information should include the complete Motorola Solutions identification number. All part orders should be directed to your local Motorola Solutions Service Organization. See your latest price pages.

Parts Identification and Ordering

Request for help in identification of non-referenced spare parts should be directed to the Customer Care Organization of Motorola Solutions local area representation. Orders for replacement parts, kits, and assemblies should be placed directly on a Motorola Solutions local distribution organization or from the Motorola Solutions Online (Extranet).

Appendix F

Maritime Radio Use in the VHF Frequency Range

Special Channel Assignments

F.1

Emergency Channel

If you are in imminent and grave danger at sea and require emergency assistance, use VHF Channel 16 to send a distress call to nearby vessels and the United States Coast Guard. Transmit the following information, in this order:

1. "MAYDAY, MAYDAY, MAYDAY."
2. "THIS IS _____, CALL SIGN _____."
   State the name of the vessel in distress 3 times, followed by the call sign or other identification of the vessel, stated 3 times.
3. Repeat "MAYDAY" and the name of the vessel.
4. "WE ARE LOCATED AT _____."
   State the position of the vessel in distress, using any information that will help responders to locate you, in example.:
   - latitude and longitude
   - bearing (state whether you are using true or magnetic north)
   - distance to a well-known landmark
   - vessel course, speed or destination
5. State the nature of the distress.
6. Specify what kind of assistance you need.
7. State the number of persons on board and the number needing medical attention, if any.
8. Mention any other information that would be helpful to responders, such as type of vessel, vessel length and/or tonnage, hull color, etc.
9. "OVER."
10. Wait for a response.
11. If you do not receive an immediate response, remain by the radio and repeat the transmission at intervals until you receive a response. Be prepared to follow any instructions given to you.

F.2

Non-Commercial Call Channel

For non-commercial transmissions, such as fishing reports, rendezvous arrangements, repair scheduling, or berthing information, use **VHF Channel 9**.

F.3

Operating Frequency Requirements

A radio designated for shipboard use must comply with Federal Communications Commission Rule Part 80 as follows:

- On ships subject to Part II of Title III of the Communications Act, the radio must be capable of operating on the 156.800 MHz frequency.
- On ships subject to the Safety Convention, the radio must be capable of operating in the:
  - Simplex mode on the ship station transmitting frequencies specified in the 156.025–157.425 MHz frequency band, and
  - Semi-duplex mode on the two frequency channels specified in the table below.

NOTE: Simplex channels 3, 21, 23, 61, 64, 81, 82, and 83 **cannot be lawfully** used by the general public in US waters.

Additional information about operating requirements in the Maritime Services can be obtained from the full text of FCC Rule Part 80 and from the US Coast Guard.

Table 109: VHF Marine Channel List

Channel Number	Frequency (MHz)	
	Transmit	Receive
1	156.050	160.650
2	156.100	160.700
3	156.150	160.750
4	156.200	160.800
5	156.250	160.850
6	156.300	–
7	156.350	160.950
8	156.400	–
9	156.450	156.450
10	156.500	156.500
11	156.550	156.550
12	156.600	156.600
13[27]	156.650	156.650
14	156.700	156.700
15[27]	156.750	156.750
16	156.800	156.800
17[27]	156.850	156.850
18	156.900	161.500
19	156.950	161.550
20	157.000	161.600

[27] Low power (1 W) only.

21	157.050	161.650
22	157.100	161.700
23	157.150	161.750
24	157.200	161.800
25	157.250	161.850
26	157.300	161.900
27	157.350	161.950
28	157.400	162.000
60	156.025	160.625
61	156.075	160.675
62	156.125	160.725
63	156.175	160.775
64	156.225	160.825
65	156.275	160.875
66	156.325	160.925
67[27]	156.375	156.375
68	156.425	156.425
69	156.475	156.475
71	156.575	156.575
72	156.625	–
73	156.675	156.675
74	156.725	156.725
75	Guard band	Guard band
76	Guard band	Guard band
77[27]	156.875	–
78	156.925	161.525
79	156.975	161.575
80	157.025	161.625
81	157.075	161.675
82	157.125	161.725
83	157.175	161.775
84	157.225	161.825
85	157.275	161.875
86	157.325	161.925
87	157.375	161.975
88	157.425	162.025

NOTE: A – in the Receive column indicates that the channel is transmit only.